# PART 13

# PARTICULAR INSTRUMENTATION AND CONTROL REQUIREMENT

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**PART-13**

**Particular Requirements – Instrumentation, Control & Automation**

## 13.1 Introduction

This part covers the particular requirements for the design, engineering, supply, Factory inspection and testing, Field testing & calibration, installation & commissioning of the instrumentation, Control and Automation (PLC-SCADA based Control System inclusive of wireless communication system) and associated plants and materials for successful operation.

## 13.2 Design Approach & Scope of Work

This section outlines the particular requirements for the instrumentation, control & automation works. This section shall be referred in conjunction to the general requirements for instrumentation, control and automation works specified. Unless specified in this section to the contrary, the system provided by the Contractor and workmanship shall comply with the General Chapters of these Requirements.

**Design Approach:** As the instrumentation, control & automation system is the main component through which the performance of the treatment plant will be assessed and the entire plant operation is via the instrumentation and control system, it is required that the agency which executes the work is well experienced in executing the work as required under this contract.The contractor shall submit the credentials of the agency which shall be executing the work for review and approval as per qualification criteria indicated below,before commencing any designworks. Only on the approval of the same, the contractor shall commence works for instrumentation, control and automation works required under this contract.Refer approved vendor list for instruments and automation. **Note**: Additionally, the contractor shall note that the approved vendor list indicated in particular requirements is only for the product and not for any executing agency to execute the work.

**Scope of Work**: The scope of instrumentation, control and automation (ICA) works for Sewage Treatment Plants, and TSPS under this contract shall comprise of the design, manufacture, supply, programming and configuration, off site testing, delivery to site, installation and erection, testing, commissioning, setting to work and provision of documentation for a complete instrumentation, control and automation system including the interfaces required to provide monitoring and control for a safe and efficient operation of the plant locally as well as remote monitoring from the centralized SCADA Center to be established under contract package CP-24 at SHIMSHA Bhavan (being established under separate contract under BWSSB Stage V project). The SCADA system shall be designed and configured to transmit complete STP, TSPS operational data (data transfer in bulk) to the centralized SCADA center's as indicated above. The SCADA mimics of the local SCADA for TSPS and STP shall be provided to the CP-24 package contractor for his design mimics and monitoring at the centralized SCADA center.

The minimum scope of work for ICA at STP and TSPS under this contract shall include on a minimum, but not be limited to:

1) Design, supply, install, test and commission a dual redundant PLC based SCADA system including redundant communication System for STP. The system shall include on a minimum , but not limited to process controller including its central process units (CPUs in redundant hot standby configuration), redundant communication modules, Local/Remote IO's (Simplex), control networks, servers, Historian server and software, operator workstations, engineering workstation and printers;

2) The main PLC comprising of the hot standby PLC system shall be installed in the administration building and linked to the main SCADA system to be installed in the SCADA control room in the administration building.
3) SCADA servers shall be redundant SCADA software servers shall be installed in server grade machines only with windows server 2019 or latest operating system available at the time of testing the control system (Factory acceptance test).
4) Design, supply, install, test and commission field & analytical instrumentation for the Entire STP;
5) Design, supply, install, test and commission laboratory equipment & Laboratory Information management system ( LIMS system) for the Entire STP and the same shall be integrated in real time with the plant SCADA system.
6) The LIMS system and its related hardware, shall be installed in the SCADA control room only and not in any other area.
7) Design, supply, install, test and commission chlorination system including its instrumentation and chlorination control units and its interface with STP PLC based SCADA system;
8) Design, supply, install, test and commission individual process systems, Vendor Package PLCs, RIO panels etc. including its instrumentation and control system units and its interface with main plant PLC system;
9) Contractor shall note that, "No separate PLC system" for monitoring and control of process system by the process vendor shall be accepted. The process vendor cannot supply the plant control and automation system. All vendors have to satisfy the qualification criteria as indicated elsewhere in the document.
10) Design, supply, install, test and commission uninterrupted power supply system to supply the entire PLC based SCADA system including the Vendor Package PLC/ Remote I/O (RIO) systems and field and analytical instrumentation, wireless communication system, LIMS and lab equipment.
11) Design, supply, test and commission standalone PLC system for TSPS with required input/output modules, field instrumentation (Electromagnetic flowmeters at the common discharge of the pumps, pressure transmitters at individual & common discharge of pumps and pressure Gauges at individual and common discharge of pumps and level transmitter, 4 point level switches (as backup to level transmitter) and redundant GPRS communication modules) ,with 15" color panel HMI enclosed in with IP - 65 rated panels along with UPS system with 60 min backup on full load to control and monitor the TSPS that shall be connected to the Sewage treatment plant (STP). The TSPS pumping station data shall be transmitted to the sewage treatment plant control system for complete control and monitoring with necessary security login and other safeguards as required.
12) The TSPS data shall be communicated in real time to the STP control system for control and monitoring at all times from the STP control system. The STP control system shall be designed and configured with each of the TSPS process mimics and all other ancillaries, electrical parameters, so that the TSPS can be controlled in real time from the STP. In the event if the STP control system is not available/shutdown, the TSPS control system shall transmit the data to the CP-24 centralized SCADA system. Once the STP control system is available, the TSPS control system shall transmit the data back to the STP control system for complete control and monitoring.
13) Control room furniture include but not limited to industrial system consoles for placing servers, workstations and printer compartments, engineering workstation and printer compartment and ergonomic designed seating systems along with chairs and file storage cabinets. On a minimum, 5 nos of ergonomically designed chairs, 3 withdrawable file storage cabinets for storing plant records shall be supplied. The system console shall be one full complete console housing all the systems.
14) The Contractor shall be responsible for the design of each instrumentation and plant monitoring system, including the selection and design of appropriate transducers, transmitters, signal conditioning devices, indicators, alarm system programmable devices, communications, cable system etc. The Contractor shall take account in his design of all installation and environmental conditions prevailing at the site.

## 13.3 Qualification Criteria for Instrumentation agency, Control & Automation agency, Lab equipment agency & Cyber Security System for design, supply, program, execution and commissioning of works

The contractor shall submit the following documentation for review and approval, as part of credentials submissions of the agency, for design, supply, program, execute and commission the works to the Employer Representative, before commencing any design ,supply or associated works. Only on the approval of the same, the contractor shall commence the design and other associated works. Contractor shall note the importance of this clause.

**Note-1**: As the instrumentation, control & automation system is the main component through which the performance of the treatment plant will be assessed and the entire plant operation is via the instrumentation and control system, it is required that the agency which executes the work is well experienced in executing the work as required under this contract.The contractor shall submit the credentials of the agency which shall be executing the work for review and approval as per qualification criteria indicated

**Note-2**: The contractor shall note that the approved vendor list indicated elsewhere in particular requirements for Instrumentation, control and automation, is only for the product make indicated.The contractor shall submit the credentials of the agency which shall be supplying & executing (design, supply, program ,execute ,test and commission ) the work for review and approval as per qualification criteria indicated below. The agency/OEM for design, supply, program, execute, test and commissioning the works, shall comply in all aspects with the qualification criteria as indicated below on a minimum.

**Note-3:** There shall be a single agency which shall design, supply, program, execute and commission the works to ensure uniformity among equipment and spare holding.

**Instrumentation:**

The agency on a minimum shall be operating under an accredited ISO 9001:2015 systems.

The agency should have minimum 10 years of experience in India in the field of instruments supply, installation, commissioning and operation and maintenance of instruments in plants as required under this contract, within India and shall demonstrate capability and resources for integrating/interfacing control systems from different manufacturers as well as coordination with multiple agencies for contract execution. The agency shall be an authorized channel partner for the instrumentation equipment for minimum three years continuous period. Verification certificates signed not less than the country head of OEM shall be submitted.

The agency shall have executed & completed at least ten STP project within India during the last ten years period, inclusive of supply, installation, commissioning and operation and maintenance period of minimum 1 year within India.

**Control & Automation:**

The contractor shall submit the following documentation as part of credentials submissions for the control & automation agency for design, supply, and program, execute and commission the works.

The agency which shall design, supply, program ,execute and commission control and automation equipment, on a minimum **,** shall be operating under an accredited ISO 9001:2015 system ,with a

minimum of 10 years' experience of having designed, executed & completed PLC based SCADA systems for STP's, inclusive of supply, installation and commissioning; and operation and maintenance period of minimum 1 year on a single facility within India during the last five years and shall demonstrate capability and resources for integrating/ interfacing control systems from different manufacturers as well as coordination with multiple agencies for contract execution.

The agency shall be an authorized channel partner for the named PLC hardware & SCADA software for minimum of 5 years on a continuous basis till date. Verification certificates signed not less than the country head of OEM shall be submitted. The agency proposed personnel shall be trained on a yearly basis by the product OEM on the proposed control system. Agency shall submit documentation to validate the same as part of credentials submission. Verification certificates signed not less than the country head of OEM shall be submitted.

The agency shall demonstrate in house FAT facility with FAT simulation panel and other required hardware and software to conduct FAT as required under this contract. Agency shall submit documentation to validate the same as part of credentials submission.

The Agency on a minimum , shall have executed & completed at least ten individual STP contracts for complete control and automation each, out of which, at least two STP shall be of minimum 100 MLD or more within India during the last five years period. Verification end user performance certificates shall be submitted for the same.
**Note:** In the event, if the OEM intends to execute (design, supply, program, execute and commission) the works, the OEM shall comply in full to the qualification criteria as required in this clause & specification.

The agency shall have a Automation manager with minimum fifteen years of relevant experience and at least two team leaders with minimum seven years of relevant experience. The agency shall have minimum five number of design engineers with at least three years of relevant experience in design, installation and Commissioning of works similar to this contract and overall capacity and process. The engineers shall be on its permanent employment. Proof of ESIC/PF should be submitted to demonstrate the permanent employment. (Associate Employer Representatives/ Advisers/ consultants shall not be considered).The agency shall submit documentation and signed resumes of the personnel as part of credentials submission. The contractor and agency shall depute only approved personnel, who's resume has been approved.

**Lab Equipment**

The agency shall be operating under an accredited ISO 9001-2015 or above Quality System on a minimum.

The agency shall be an authorized channel partner for the equipment.

The agency shall have executed & completed at least ten projects for setting up of STP /drinking water lab & testing facility within India in Public sector units/Govt. agencies during the last five years period, inclusive of supply, installation, commissioning of the laboratory equipment. Verification end user performance certificates shall be submitted for the same.

## 13.4 CONTROL SYSTEM – DESIGN & CONSTRUCTION FOR STP AND TSPS

The PLCs and Input/output modules used for the Works shall be from the same manufacturer and series as mentioned in the vendor list and shall as far as be practical allow for the interchange of plug in parts.

The PLCs and the central HMI shall be linked over dual line local area network (LAN) which shall be established on optic fiber cable with a single mode glass type.

A general arrangement of a typical control system is shown in the Drawings.
The control systems shall recover fully to a normal operational state on restoration of the power (either from the mains or the generator) after a power failure without manual intervention. (i. e. to remove doubt this requirement refers to a real failure of power to the control system such as would be experienced if the control system UPS s were not present).

In all cases, facilities shall be provided to permit these automatic controls to be overridden and the systems to be manually controlled.
Local manual controls shall be located adjacent to Plant where required for day to day operation. All drives essential for the continuous operation of the plant shall be provided with a standby.

The process control system must be state-of-the-art in terms of structure and function as a process information and control system and its hardware and software must be future-oriented. The control system should be a modern system with an appealing user interface, open to the office and process world, with sophisticated and reliable functions, efficient to configure and scalable for simple and complex tasks.

The communication channels modules for the connection to the Programmable logical controllers via various communications media must be included in the scope of delivery of the control system, the same applies to drivers for simple types of coupling such as point-to-point via the MPI interface. In addition, it should be possible to establish the coupling to other devices and applications from various manufacturers via the standardized software interface OPC.

**Integral online parameterization option**

A prerequisite is a comprehensive parameterization system that is integrated in the system, which allows the user to adapt the scope of functions and the functionality to any changed requirements without any programming expertise. The system must offer the option for carrying out these parameterization operations online. In practice, this means that the respective editor can run in a second window during operation and the configuration engineer can make changes to his application without exiting process mode and also without affecting the background activities. In addition, it should be possible to make configuration changes on the client as well.

**Hardware**

The control system hardware shall consist of field controls which comprises on a minimum but not limited to:

Hot standby PLC for STP
Standalone PLC with 15” color touch HMI for TSPS;
Redundant power supplies for all PLC & RIO;
15” color touch HMIs for all RIO panels;

field cabling interfaces.
and central controls which comprises:
Dual Redundant SCADA servers on server grade machines
Engineering work station
Operator work station
Historian station connected to NAS server
LIMS station
CCTV System & Fire Alarm System inside Building;
Uninterruptible power supply & Battery Bank.
And other ancillary systems as required under this contract.

The filed instrumentation & analytical instrumentation shall also form an integral part of the control system.

The control panels shall provide separate areas for the PLC, internal power distribution, instrumentation, field cabling and for any surge (lightning) protection devices (SPD s). A separate instrumentation earth (a 'clean' earth) shall be established within the control panel. Instrumentation and control cable screens shall be connected to this earth.

**Note:**
***The central controls (SCADA) shall be located in the administration building(SCADA control room) for the monitoring of the treatment plant which shall be at central location of the Plant. The complete PLC based SCADA system inclusive of the Vendor Package PLC/RIO systems shall be housed in AC environment. Requirement of Air conditioning, humidity control etc. shall be as per Manufacturer's recommendations for all PLC system cabinets, marshalling, RIO Panels as well as the Vendor Package PLC Systems.***

***The control room shall be designed to have a complete view of the STP plant from the control room without any obstruction. Full length glass windows shall be provided in the control room (from floor to ceiling), in addition to the false flooring and false ceiling. No cable shall be laid on the control room floor and the same shall be routed through ducts and conduits below the flooring. The contractor shall note that no UPS system and related battery backup system shall be installed in the control room. There shall be separate room provided for the UPS system.***

**Power Supply**

The control system shall be powered from main Un-interruptible Power Supply System (UPS) located in the Panel Room of the Control Room with a separate room for Batteries. In general power supply for vendor package PLCs/ RIO panel or all other ICA System present in the field shall be supplied from same UPS system.

These shall be sized to provide sufficient power to maintain the instrumentation & control system (inclusive of Sewage / Treated water quality monitoring instrumentation, vendor package instrumentation, LIMS system) systems functioning for a period of not less than 120 minutes on full load.

The UPS System shall be free standing provided with a bypass Transformer. The status of UPS shall be monitored and an alarm shall be raised via the control system if a fault occurs or the UPS battery supply is about to expire.

**Voltages**

The following control voltages shall be used:

| Item | Voltage |
|---|---|
| 1. within starter enclosures | 240 V AC |
| 2. instrumentation power supplies | 240 V AC / 24 V DC |
| 3. PLC inputs cards | 24 V DC |
| 4. PLC outputs | 24 V DC |

**Control System Protection**

1. **Short Circuit**
   All circuits shall be protected against short circuit by the provision of adequate numbers of fuses or miniature circuit breakers.
   For ease of maintenance and system security power supplies to each instrument loop and each PLC output shall be protected with an individual fuse (terminal type).

2. **Surge Protection**
   Surge protection devices (SPDs) shall be provided at the control panel end of all instrumentation and control cables which run for distances in excess of 50 m outside the confines of the building in which the CP is housed. The SPD s shall be grouped in a specific area within the CP to ensure 'dirty' signal cables do not come into direct contact with 'clean' signal cables.

**Duty / Standby Drives**

The duty pump for each duty / standby pair shall be selected at the local control panel and the Plant SCADA system..

The control logic shall automatically start an 'available' standby in the event of the duty drive failing. The new duty drive shall take on the role of duty drive in all respects and shall continue to run as duty until manually reselected to standby or it fails.

**Interlocking**

Hard wired interlocking shall be provided for safety circuits such as:

- motor protection;
- dry run protection;
- emergency stop circuitry for all pumps;
- rotation monitor.

In addition drives stopped as a result of the action of hardwired interlocks shall in addition have a fault signal conveyed to the drive in order that the PLC drive run output is removed.
Soft wired interlocking shall be provided by the PLC for process control and for safety trips when the signal is derived from a remote source (e.g. stopping of the treatment plant as a result of a high level in a downstream Treated water Storage Tank).

**Alarm Annunciation**

Alarms shall be annunciated at three locations, at the drive starter, at the local Controller /RIO HMI as applicable and at the Local SCADA. A philosophy shall be adopted that all alarms associated with a drive shall be annunciated at the starter whilst a general alarm only for that drive shall be enunciated at the HMIs. Therefore the operator observing a general alarm at an HMI shall have to go to the starter concerned to determine the exact cause of the alarm condition.

**Communication Monitoring**

The control system shall continuously monitor LAN communications and raise an alarm at the central SCADA if communications should fail between the SCADA and a controlling PLC/Vendor PLC / RIO or between PLCs if inter-PLC communication is being used. A separate SCADA screen (mimic) showing the real time status of PLC's, I/O modules, LAN communication ,RIO status, etc. is to be incorporated.

## 13.5 Interface to the Central SCADA Stations at Centralized SCADA Center at Shimsha Bhavan.

### (a) General

Data from the Terminal Pumping Water Stations (TSPS) is required to be passed to the respective Sewage Treatment Plant for use in its control and monitoring and for onward transmission of STP data to enable remote monitoring from the centralized SCADA Center being established under contract package CP-24 at Shimsha Bhavan.

### (b) The Interface

The interface shall be housed in a separate IP-65 rated control panel provided by the Contractor. The Contractor shall provide facilities to output from control system via this control panel the signals to be sent and to accept the signals provided. The Contractor shall provide the redundant GPRS wireless communication from STP system to contract package CP-24 SCADA center at Shimsha Bhavan.

All required data from the STP control systems including TSPS data shall be communicated to the Central SCADA Centres at contract package CP-24 centralized SCADA center via wireless GPRS redundant network. Communication between the interface control panel of the Central SCADA System and the STP control system shall be carried out by the STP Contractor. The Contractor shall co-ordinate in full with other Contractors to interface with Central SCADA System so that the entire SCADA system for STP system can be provided completely.

**Interoperability Test & Integration co-ordination**:

The contractor shall conduct a interoperability test to confirm & demonstrate that the local control system data can be read & written by the contract package CP-24 SCADA center at Shimsha Bhavan,using appropriate OPC server & client software via the interface panel and local PLC/SCADA. The test shall be carried out in presence & co-ordination with the centralized SCADA control centre contractor.

It is required that the STP contractor maps his local I/O's for integration in the same format as required at centralized SCADA control centre.

The STP contractor shall co-ordinate fully with the centralized SCADA control centre contractor for integration tests .The STP contractor shall be fully responsible for data to be made available at the centralized SCADA center at all times.

**(c) Data to be provided by the STP & TSPS Control System to CP-24 Centralized SCADA center.**

The STP contractor shall provide complete SCADA screen dumps to enable complete STP and TSPS monitoring from the Centralized SCADA center.

The following signals are to be transmitted by the Contractor on a minimum, but not limited to:

- Inlet Sewage flow (Ml/day);
- Treated Sewage flow (Ml/day);
- Inlet & Treated Sewage parameters (Lab data);
- combined filtrate flow (Ml/day);
- final turbidity (NTU);
- final chlorine residual (mg/l);
- power consumed / day (kWh);
- chemical consumption;
- complete LIMS data;
- total flow / day (Ml);
- power outage hours / day (h);
- power outage at treatment works;
- Complete plant maintenance record ;
- Real time online inlet and effluent monitoring system data;
- Total plant SCADA operational screen dumps
- Alarms
- Asset information with tags
- Reports
- Local Historian data
- Status of fire alarm and suppression system

Note: In addition to the above, the Local plant CCTV feeds shall also be configured to be made available for remote viewing from the centralized SCADA center in real time.

## 13.6 System Completeness

This section of specifications defines the particular requirements of instrumentation, control & automation works to be installed at STP and TSPS.

Irrespective of the detailed specifications of the respective items detailed in the various chapters, the Contractor shall be required to provide all the equipment, accessories, cabling, earthing, providing necessary transducers/sensors, system hardware/software, programming logic, interlocks ,cabinets, panels etc. to achieve the functional requirements described in the Bid Document. The System completeness shall be the Contractor's responsibility.

**Note:** In FAT, all the field instruments shall be tested for functionality as per contract requirements only at the manufacturers work location where the equipment is manufactured. Quality assurance plan (QAP) shall be submitted along with the datasheets for review and approval before any inspections call is initiated incorporating the above.

**Note:** Bidder shall refer to the Part-14 -Inspection, testing and commissioning requirements and ensure that the QAP is in full compliance to the requirements specified under.

## 13.7 Field Instrumentation and Control

Each field instrument shall be operable in local mode and have display functions in SCADA. The Contractor shall be responsible for providing the appropriate signals at the locations required to provide the specified control and monitoring functions.

The Contractor shall ensure that field measuring systems shall respond quickly to any changes of the measured process variables.

All field instruments shall, as far as practicable, be mounted in a location that shall be free of vibration and shall be powered from the instrument control system.

24V dc power wiring for field instruments shall be individually fused and provided with a means of disconnecting the power without disturbing terminated wiring (e.g. knife-switch-type terminal blocks). Visual indication of a blown fuse condition shall be provided.

All field instrument components shall be of a proven and reliable design and shall have a high degree of uniformity and shall, wherever possible, be interchangeable. The design shall facilitate easy maintenance and repair, taking into account the availability of access routes through plant and structures generally.

Field Instruments shall perform sensing, indicating, transmitting and controlling. The devices shall generally interface with the SCADA, either directly or indirectly. The materials of those parts of the field instruments, including piping material, which are exposed to the measured media shall be compatible with the conditions of the respective media and of the ambient fluid and atmospheric conditions.

All field instruments shall be mounted within enclosures that are corrosion proof, dust proof and waterproof to provide a minimum protection specified in elsewhere in this Specification. The enclosure shall be rated to minimum IP 65.The enclosure design shall be submitted along with the instrument datasheet for review and approval before any design of the same.

All field instruments, including the components, shall be tropicalized and designed for the ambient conditions detailed elsewhere in this Specification. Lighting protection barriers shall be used for protecting transmitters and receiving instruments from the surge voltage due to lighting strike. Lighting protection barriers shall be supplied at both receiving and sending ends for all signals from outside building and those installed between the buildings.

## 13.8 Instrumentation Design Criteria

The design criteria to be applied to instrumentation systems shall be as follows:

1) all instruments shall be suitable for continuous operation;
2) all transmitting instruments shall have a 4 - 20 mA HART linear output and HARt communicator shall be supplied along with the instrument ;
3) all digital outputs shall be volt free;
4) all instruments shall be designed for the ambient conditions of temperature and humidity;
5) all wetted parts of instruments sensors shall be non-corrosive and suitable for use with sewage;
6) all instrumentation systems for use outdoor shall be protected to IP 65;
7) all analogue displays shall be of the digital type with no moving parts utilising back lit liquid crystal diode LED technology;
8) instrumentation shall utilise solid state electronic technology and avoid the use where practical of any moving parts;
9) minimum maintenance requirement;
10) Instrumentation shall resume operation automatically on the application of power following a power failure.
11) All analytical instruments shall be single channel and have individual analyzer units only.

Instrumentation systems shall be provided as detailed in the Employer's Requirements on a minimum and as necessary for the efficient and safe operation of the treatment plant

The Contractor shall provide systems to measure any other parameter required for the efficient and safe operation of the treatment plant.

Instrumentation sensors shall be suitable for the environment in which they are expected to work. Sensor located in hazardous (flammable) or potentially hazardous atmospheres shall be certified for use in these areas.

All Sensors should be of self-cleaning type.

Instrumentation shall be selected and installed in accordance with the manufacturer's instructions. Wherever practical components of similar systems shall be interchangeable, i.e., open channel flume flow measuring systems and open sump or tank level measurement and pump control systems shall incorporate identical sensors and converter units. Instrumentation converter units shall where practical be located in the associated MCC common control panel well away from any injurious effects of the process.

## 13.9 Flow Measurement and Control

The Contractor shall use electromagnetic flow meters, for all closed pipe liquid flow measurement as the standard flow meters under this contract. The flowmeter provided shall match with the line size on which the flowmeter is being installed.Each flow meter shall be installed in the pipeline within a suitable access chamber. The access chamber shall be designed to provide adequate space for personnel access to the chamber and around the flow meter for maintenance. The flow meter system shall provide flow rate and totalized flow indication.

The pressure rating of the flow meter and flanges shall be equal to or greater than that of the pipeline within which it is installed. The preferred location for the flow meter converter/transmitter units is within a building. Where this is not possible, then the converter shall be installed in a suitable above ground enclosure providing the converter with suitable mechanical and environmental protection.

The flow signal converters/transmitters shall provide 4-20mA output linearly proportional to the rate of flow and shall provide a pulse output for flow totalizing. The flow meter electronic supervisory unit shall display the following on a minimum:

- Flow rate;
- Flow total-totalizer;
- High flow rate alarm;
- Low flow rate alarm.

Signals for the items above shall form inputs to the PLC and SCADA and be utilized within Operator displays. The integrator used for the second item above shall have at least six digits.

Each flow meter shall be provided with downstream and upstream isolation valve including the washout facility.

The sewage water inlet flow shall be measured using an open channel flume type system located in the inlet channel. The head loss across the flume shall be monitored using ultrasonic fully sealed detectors. A local readout of flow &totalized in Ml/day shall be provided.

**Electromagnetic Flow Meter**

Full bore bi-directional electromagnetic flow meters shall be designed, manufactured and calibrated as per ISO/IEC 17025 standard. Meters shall also have actual Flow rate & Totalized value. The accuracy shall be +/- 0.5% of reading.

The sensors shall be as per ISO standard lengths (ISO 13359), so that inter-changeability can be carried out for the applicable flow meter sizes. The sensor shall also have built in grounding and empty pipe detection electrodes of SS316 for detecting partial flow condition & efficient operation purposes. The liner material shall be Polyurethane (PU) only.No other alternate liner material shall be accepted. The sensor & transmitter shall be capable of working in tropical environment.

The sensors shall be rated IP68. The transmitter shall be rated IP67 in line with local operating conditions. Installations shall be made with cables and /or conduits that guarantee the integrity of the system under all operational conditions. The transmitter/ converter shall be wall-mounted type with a 2 line display for the indication of Actual Flow rate & Totalized value. A glass window within the protection enclosure with optical switches shall be provided for local reading purposes.

The enclosure material shall be non-corrosive and of die cast material. Magnetic flow meters should be supplied with built in software feature to analyze and continuously monitor the health of the sensor, display errors in text format. Transmitter should be capable of performing the verification program on demand or on request without taking meter off the line.
The transmitter shall be capable of being fully programmable. It shall have a set-up menu so that all relevant parameters may be user-set from the self-prompting driven menu.

The transmitter shall have totalizer units and shall have one (1) scalable pulse output & one (1) current i.e.4-20mA HART output. The current output shall be galvanically isolated. It shall be fitted with switched mode power supply capability 0-250V or 24 DC and 45-65Hz to cope with power transients without damage. The Totalizer value shall be protected by EEPROM during power outage, and utilizes an overflow counter.

The transmitter shall be having facility of indicating flow measurement. It shall be possible to separate the sensor and transmitters up to 200 meters without the need for signal boosters or amplifiers

Detailed technical specification of Full bore electromagnetic flow meter is as below

| **General** | | |
|---|---|---|
| 1 | Application (Suitable for) | Sewage Water |
| 2 | Op Temperature | 0 to 50 Deg C Max |
| 3 | Op Pressure | Max 6 Bar g |
| 4 | Measurement | Instantaneous water flow Rate, Totalized Flow |
| **Flow Sensor** | | |
| 5 | Type | In-Line Full Bore Electromagnetic flow meter. |
| 6 | Power supply type | Mains operated |
| 7 | Sizes (mm) /Qty | As per line size |
| 8 | Sensor Type | Pulsed DC |
| 9 | Process Connection | Flanged type |

| | | |
|---|---|---|
| 10 | Weather Protection Class | IP68 as per IS 13947 |
| 11 | Full Scale Velocity | 0.2 to 3 m/s, vendor to provide the detailed sizing calculations based on the process details. |
| 12 | Electrodes | SS 316 L, Total 4 Electrodes system.<br>Measuring electrodes – 2 Nos.<br>Grounding electrode- 1 No. and Empty pipe detection electrode -1 No. |
| 13 | Coil Housing | Powder-coated die-cast aluminium Anti corrosive grade with IP 68 protection class with minimum 20 meter cable for remote mount transmitter connection |
| 14 | Flanges | Carbon Steel PN 10 as per EN 1092-1 |
| 15 | Flow sensor Grounding | Grounding rings shall also be acceptable |
| 16 | Flow Tube material | SS304 |
| 17 | Flow Tube Liner | Polyurethane PTFE |
| | | |
| | | |
| **Flow Transmitter Unit** | | |
| 1 | Type | Microprocessor based with facility to configure the range |
| 2 | Type of Display | 2 -Line LCD display with operation keys (touch control) |
| 3 | Transmitter Type | Remote Wall Mounted with 5 cable glands, integrated fixing points for wall mounting, with sensor interface |
| 4 | Units for Display | Flow Rate m3/Hr, Totalized Flow ML |
| 5 | Input | From Flow Tube |
| 6 | Accuracy | +/- 0.5 % of Measured Value |
| 7 | Operation | Via local display, Via HART handheld terminal ( Shall be supplied along with flowmeter) |
| 8 | Output proportional to Flow rate | Current output (4–20 mA HART); pulse/frequency/switch output (2); status input |
| 9 | Power supply | 0-250 VAC, 45-65Hz – Optional - 11 to 40 V DC |
| 10 | Self-diagnostic feature | Following minimum diagnostic features shall be provided Empty pipe detection, system diagnostic features to the plant control system for monitoring. |
| 11 | Transmitter enclosure material | Non-corrosive, Die Cast Aluminium |
| 12 | Communication | Wired communication with control system and HART based integrated and service interface |
| 13 | Memory | 100% secure data storage |
| 14 | Weather Protection Class | IP 67 (NEMA 4X) for flow transmitter |
| 14 | Calibration Method | Gravimetric Method ISO 4185 / volumetric method (ISO 8316). All test equipment fully traceable to national and international standards with minimum 5 point |

| | | |
|---|---|---|
| | | calibration. |
| 15 | Flow calibration rig | Duly Accredited according to ISO/IEC 17025 of the flowmeter manufacturer |

**Note-1:** The flow meter manufacturer/supplier shall have full ISO 9000 series accreditation and fully traceable calibration methods. The suppliers shall also have a testing facility in India so that methodology and procedures can be verified. Each meter shall be wet calibrated with 5 point calibration to verify performance in accordance with the specification & submit report for the same. The flowmeter manufacturer testing facility shall be duly accredited in accordance with ISO/IEC 17025 standards.

In the event if the meter manufacturer does not have a testing facility in India, the flow meter shall be tested & inspected before shipping at the Manufacturers factory works, where the meter has been manufactured.

**Note-2:** The flow meter manufacturer shall have local offices in India and full service capability in the major cities (metro's) throughout the country. Full contact details for key personnel, shall be furnished on request. The supplier shall provide evidence of at least fifteen years involvement in the manufacturing of meters worldwide.

**Note-3:** The flow meter manufacturer shall provide full data on each meter required, including optimizing and sizing programs calculation sheet.

## 13.10 Thermal mass flow meter for gas (air) for continuous measurement of flow

Thermal mass flow meter shall be utilized as mass air flow meters to measure air flow or bio gas flow as applicable under this contract.
The sensor shall not cause any pressure loss and no pressure and temperature compensation shall be required. The meter shall be able to measure Mass flow, temperature, volume flow and energy flow

The degree of protection for the sensor and transmitter shall be rated to IP67.

| | |
|---|---|
| Measuring Principle | Thermal dispersion principle |
| Sensor features | Shall offer high accuracy and repeatability for a wide range of utility and process gases. |
| Measuring Task | Flow (Mass), Gas temperature, Gas heat flow |
| Accuracy | +/- 1.5% |
| Sensor, Insertion tube material | Stainless steel |
| Compression fitting seal | PEEK |
| Material process connection | Stainless steel |
| Transmitter housing material, Coating | Powder coated die-cast aluminium, powder coating |
| Degree of protection | IP67 (NEMA 4X) for transmitter and sensor |
| Max. measured error | Gas: 1.5% or (10 to 100% o.f.s.) |
| Display/Operation | LCD/LED: back-lit, Configuration via local display and operating tools shall be possible |
| Outputs | 4-20mA HART (active/passive selectable), pulse, frequency, status, instrument diagnostic. HART |

| | |
|---|---|
| | communicator shall be supplied along with the instruments on a minimum. |
| Hazardous area approvals | Required (As applicable) |

**Note-1:** The flow meter manufacturer/supplier shall have full ISO 9000 series accreditation and fully traceable calibration methods. The suppliers shall also have a testing facility in India so that methodology and procedures can be verified. Each meter shall be wet calibrated with at sufficient flow rates to verify performance in accordance with the specification & submit report for the same. The testing facility shall be duly accredited in accordance with ISO/IEC 17025 standards.

In the event if the meter manufacturer does not have a testing facility in India, the flow meter shall be tested & inspected before shipping at the Manufacturers factory works, where the meter has been manufactured.

**Note-2:** The flow meter manufacturer shall have local offices in India and full service capability in the major cities (metro's) throughout the country. Full contact details for key personnel, shall be furnished on request. The supplier shall provide evidence of at least fifteen years involvement in the manufacturing of meters worldwide.

**Note-3:** The flow meter manufacturer shall provide full data on each meter required, including optimizing and sizing programs calculation sheet.

## 13.11 Flow Switches (Load Monitor)

1) The load (kW) monitor shall be suitable for mounting within the appropriate motor starter section of the motor control centre. The device shall be used primarily to detect low or no flow situations. However, it may be utilised to detect overload situations where appropriate.
2) In low or no flow mode the load monitor shall monitor drive power. If the measurement of the power falls below an adjustable set value (P-min) an output-relay shall be de-energised to cause the pump set to stop.
3) The monitor shall incorporate the following features:

a) DIN-rail mounting
b) adjustable start-up delay time
c) adjustable reaction time
d) three monitoring measuring ranges, selected externally on unit
e) normally energised, or de-energised mode
f) output signal may be latched, or automatically reset
g) LED indicators for mains on indication and status
h) Relay output; 1 No. changeover contact.

4) The monitor performance specification shall be as follows:

a) Reaction time - 3 to 30 seconds adjustable
b) Start-up delay time - 0.15 for 20 seconds adjustable
c) Switching capability - 1 A (24 V), 0.1-8 A 250 V ac, 1 100 VA)
d) Maximum switching current - 10 A

## 13.12 Rotameter

| | |
|---|---|
| Type | On-line up to 2". By-pass above 2" |
| Metering tube | Borosilicate glass |

| | |
|---|---|
| Float | AISI 316-SS unless the process fluid demands some other material. |
| Body MOC | AISI 316-SS |
| Scale | Graduated- Engraved black on white background. |
| Process connection | Flanged |
| Accuracy | ± 2% of full scale detection or better for on-line type and ±4% of full-scale detection or better for by-pass Type. |
| Nameplate | Tag number, service engraved in stainless steel tag plate |
| Accessories | Slip-on orifice plate of 316-SS and taps of Stainless Steel as per application requirements. Applicable |

SS Isolation valves and SS Range Orifice – for Bypass type rotameters.

## 13.13 Level Measurement and Control

The following section describes the minimum technical specifications for level measurement and control under this contract.

Owing to the nature of sewage and sewage sludges, non-contact methods of level measurement are preferred. Where foaming problems are identified as a local concern, the level measurement by level transducer shall be considered. Float switches are reserved as backup to the level indicating transmitters.

Sensing heads shall be mounted on 316 stainless steel brackets and positioned to ensure an unhindered beam path and ease of access for maintenance.

## 13.14 Radar Microwave Level transmitter:

| | **Transmitter** | |
|---|---|---|
| 1 | Type | Microwave Level measurement |
| 2 | Principle | Pulse Time of flight |
| 3 | Output | 4-20 mA HART current , instrument diagnostic |
| 4 | Housing | Die Cast Aluminum |
| 5 | Electromagnetic compatibility | Interference Immunity to EN 61326, Annex A (Industrial) and NAMUR Recommendation NE 21 (EMC) |
| 6 | Ingress Protection | IP 67 |
| 7 | Accuracy | +/- 3 mm |
| 8 | Area Classification | Non-Hazardous. Hazardous |
| 9 | Display | 4 line LCD display. Service: Display of Envelope curve. |
| 10 | Configuration | Using Keypad on display |
| | **Sensor** | |
| 11 | Range | Liquids 0 to 5m and 0 -10m depending on Tank size |
| 12 | Temperature range | -40°C ... +80°C |
| 13 | Max Pressure | 3 bar abs |
| 14 | Materials | Sensor: PVDF Seal: EPDM |

| | | |
|---|---|---|
| 15 | Antenna seal | FKM Viton |
| 16 | Process connection | Threaded or universal flange dependent on model selection |
| 17 | Degree of protection | IP65 |

## 13.15 Ultrasonic Level transmitter:

| | **Transmitter** | |
|---|---|---|
| 1 | Type | Ultrasonic |
| 2 | Principle | Pulse Time of flight |
| 3 | Output | 4-20 mA HART current, instrument diagnostics |
| 4 | Housing | Die Cast Aluminum |
| 5 | Electromagnetic compatibility | Interference emission to EN 61326; Equipment class B Interference immunity to EN 61326; Appendix A (Industrial) |
| 6 | Ingress Protection | IP67 |
| 7 | Accuracy | +/- 2 mm or 4 mm depending on selection or 0.2% of set measuring distance Whichever is greater. |
| 8 | Area Classification | Non-Hazardous/Hazardous as applicable |
| 9 | Temperature range | -40°C ... +80°C |
| | | |
| 10 | Display | 4 line LCD display. Menu guided operation Display of Envelope curve. |
| 11 | Configuration | Using Keypad on display |
| | **Sensor** | |
| 12 | Range | Liquids 0 to 5m and 0 -10m depending on Tank size |
| 13 | Temperature range | -40°C ... +80°C |
| 14 | Max Pressure | 3 bar abs |
| 15 | Materials | Sensor: PVDF Seal: EPDM |
| 16 | Process connection | Threaded or universal flange dependent on model selection |
| 17 | Degree of protection | IP68 |

## 13.16 Float Switches

1) Level switches of the buoyancy type shall consist of a non-mercury switch with changeover action enclosed in a non-corrodible material. A balance weight shall also be incorporated in the switch to counteract the buoyancy effect of the specific gravity of the particular fluid. The connecting cable shall be factory sealed to the switch. The switches shall be installed in a stiller tube in the wells.
2) Level switches shall be installed with a minimum of 3 m of spare connecting cable neatly coiled at a supporting bracket. The connecting cable fixing shall facilitate any alteration in operating level within the limit of the spare cable.
3) The level switches shall act as backup to the level transmitter in the control interlock sequence.

## 13.17 Sludge Blanket Level Monitor

1) The device shall be used to detect the pressure of sludge or a sludge blanket level.

2) The device shall operate on ultrasonic principles employing two sensors acting as transmitter and receiver. The absorption of the beam by the presence of a sludge or slurry shall initiate a switching action which may be used for control purposes.
3) The device shall be unaffected by vibration, temperature or viscosity of medium being detected.
4) The ultrasonic sensor frequency shall be selected with regard to the medium in which it is to be used.
5) For sludge blanket level detection the sensor shall be suspended/fixed in the tank concerned at the required level. The sensor shall be secured to a corrosion resistant pipe in order to 'steady' the sensor. It shall be possible to adjust the level of the sensor and to remove it easily if required for checking and cleaning.
6) Pipe mounted sludge detectors shall be mounted on opposite sides of a pipe section with the sensor faces flush with the inner pipe surface, in order to promote self-cleaning of the sensor faces by the flow of sludge. The pipe section shall be lined with an epoxy lining or other suitable chemical resistant lining material in order to prevent the build-up of grease in the region of the sensors.
7) The sensors shall operate in conjunction with a converter. The converter shall be provided with the following features:

a) LED sensor status indicators
b) DPCO relay output
c) Internally selectable time delays (typically 0.5 to 30 seconds).

8) The converter shall be provided with sensitivity control typically providing a range of 1: 20.

## 13.18 Level Gauge (Float & Tape)

| | | | |
|---|---|---|---|
| 1) | Type | : | Float and Tape |
| 2) | Float & Tape MOC | : | AISI 316 |
| 3) | Pulley Housing | : | Aluminum |
| 4) | Guide wire | : | SS 316 Stainless steel |
| 5) | Accuracy | : | +/- 2 mm |
| 6) | Indication | : | On circular or vertical dial |
| 7) | Rating | : | Twice the design pressure |

## 13.19 Sight Glass

| | | | |
|---|---|---|---|
| 1) | Type | : | Flap-type |
| 2) | End connection | : | Screwed / Flanged |
| 3) | Material | | |
| | a) Body | : | SS-304 |
| | b) Cover Plate | : | SS-304 |
| | c) Indicator | : | SS-316 |
| 4) | Sight Glass | : | Toughened Borosilicate |
| 5) | Gasket | : | Neoprene |
| 6) | Bolts & Nut | : | High tensile steel |
| 7) | Hydraulic Test Pressure | : | 1.5 times maximum working pressure |
| 8) | Accessories | : | As required |

## 13.20 Pressure Instrumentation

**Pressure Gauges & Pressure Switches:**

1) Pressure gauges shall comply with BS EN 837- Parts 1, 2 and 3. Pressure Gauges, Switches & Indicating Transmitters shall have over range protection up to 1.5 times the maximum anticipated line pressure.
2) Internal parts shall be of stainless steel, bronze or other corrosion resistant material.

3) All Pressure Gauges, Switches shall be supplied complete with isolating valves and calibration points to enable calibration or removal without loss of fluid.
4) Where compensation of more than 2% of the instrument span is needed for the difference in level between the instrument and the tapping point, the reading shall be suitably adjusted and the amount of compensation marked upon the dial.
5) Pressure and differential pressure switches shall have contacts with separate 'cut in' and 'cut out' pressure values.
6) The nominal pressure values at which pressure switches operate shall be fully adjustable over the whole range of the instrument and the set value(s) shall be clearly indicated by means of a scale and pointer.
7) Pressure monitoring shall be by a sensor suitable for the medium and pressure/level range.
8) The sensor shall be selected to provide adequate sensitivity over the working range and be capable of sustaining a 400% overpressure without damage. The sensor shall be suitable for either free wire suspension in the medium or fitted remotely and provided with threaded sockets to permit connection of pressure pipe work.
9) A transmitter shall be provided either integral with the transducer or separately mounted and converting the signals received from the transducer to a 4 to 20 mA signal proportional to the range specified.
10) The transmitter shall have provision for span and zero adjustment.

**Pressure Transmitters:**

Pressure measuring system shall consist of pressure transmitter and digital pressure indicator and any other items required to complete the pressure measuring system. Pressure transmitter shall be rugged in construction and shall be suitable for continuous operation. Pressure transmitters shall be designed for operation over 130% of full range. It should have EEPROM for storing of history data.
Pressure transmitter shall be suitable for field mounting. They shall provide 4-20 mA Current output proportional to pressure. Transmitter output shall be isolated and shall be suitable for transmitting over long distance. Pressure transmitters shall have high degree of weatherproof protection as specified in technical particular. Pressure transmitters shall have LCD display to indicate pressure.

The Contractor shall mark the exact location of pressure measuring point on the pipe line. The contractor shall provide all the hardware items including manifolds, nuts, bolts, pipes, valves, gaskets etc. required for the work.

| Sr. No. | Detailed specifications for Pressure Transmitters | |
|---|---|---|
| 1 | Specifications | Pressure Range 0 to 10 /20/50/ 100 Kg/cm2 g |
| 2 | Process Temperature range | -20 to +125 deg.C. |
| 3 | Output Signal | 4 to 20 mA with superimposed digital communication protocol HART 6.0, 2-wire, instrument diagnostic |
| 4 | Signal range – | 4 to 20 mA HART<br>3.8 to 20.5 mA |
| 5 | Signal on alarm | As per NAMUR NE 43<br>• 4 to 20 mA HART |
| 6 | Resolution | Current output: 1 micro Amp |
| 7 | Response time | <250 ms |

| Sr. No. | Detailed specifications for Pressure Transmitters | |
|---|---|---|
| 8 | Damping | required |
| 9 | Supply voltage | 11.5 to 45 V DC |
| 10 | Reference accuracy | ± 0.1% |
| 11 | Housing | Die Cast Alu. Housing |
| 12 | Diaphragm Material | Ceramic |
| 13 | Long Term Stability | ± 0.25% URL/year |
| 14 | Turn Down | 10 : 1 |

**Differential Pressure Transmitter**

| | | |
|---|---|---|
| 1 | Working Principle | Smart |
| 2 | Type | 2-Wire |
| 3 | Output signal | Superimposed field bus over 4-20 mA DC. |
| 4 | Signal Processing Unit | Silicon solid-state electronic circuitry |
| 5 | Measuring element | Capsule/ Diaphragm |
| 6 | Element material | AISI-316 (Stainless Steel) or better |
| 7 | Static Pressure/ Overload Pressure | Maximum line (or static) pressure on either side without permanent deformation or loss of accuracy |
| 8 | Turn-down ratio | 100 : 1 minimum |
| 9 | Span and Zero | Locally adjustable, non-interacting |
| 10 | Enclosure class | IP-65 |
| 11 | Zero suppression / Elevation | At least 100% of Span |
| 12 | Output Indicator | LCD type |
| 13 | Performance:- | |
| | • Accuracy | ±0.1 % of span or better |
| | • Repeatability | ± 0.05 % of span or better |
| | • Response time | 100 mSec or better |
| 14 | Sealing / Isolation | Extended diaphragm with 5 meters SS armoured capillary for viscous fluid applications. |
| 15 | Accessories | a) Universal mounting bracket suitable for 2” pipe mounting. |
| | | b) High tensile carbon steel U-bolts. |
| | | c) Companion flange with nuts, bolts and gaskets. |
| | | d) Hand held configurator kit for calibration of Smart Transmitter. |
| | | e) ½” NPT cable gland |
| | | f) ½” NPT generally 5-valve stainless steel manifold, constructed from SS316 bar stock. |

## 13.21 Temperature Instrumentation

Unless otherwise specified, platinum resistance elements shall be used for measuring spans of up to 200°C and chromel-alumel thermocouples for spans exceeding 200°C.

The accuracy for temperature meters shall be ±0.03% of span. Configuration data shall be stored in the EEPROM memory.

In critical and important application, the temperature sensors shall be of a dual type arrangement for easy replacement. Each temperature sensor, unless otherwise specified, shall have a stainless steel thermo well, or pocket-and-extension assembly, non-corrodible metal sheath and waterproof terminal head. Pockets for steam, oil and pressurized-water lines shall be welded; pockets for other duties shall be screwed. The sensor assembly shall be designed to permit removal of the temperature element without twisting the leads.

Platinum resistance thermometers shall comply with BS 1041 and BS EN 60751 or equivalent Indian Standards on the approval of the Employer Representative. Sensors shall have a resistance of 100 ohms at 0°C and shall conform to the European standard curve (DIN 43720), where Alpha = 0.00385. Each element shall be artificially aged during manufacture. Terminal heads and amplifiers shall be designed for four-wire connections between head and amplifier. Platinum resistance elements shall be spring-loaded and fully encapsulated in ceramic material and the elements and high-temperature-resistant lead wires shall be hermetically sealed. The associated resistance-to-current converters shall have zero and span adjustments and input-output circuit isolation.

Thermocouples shall be of the mineral-insulated type and unless otherwise specified shall be of the chromel-alumel (nickel-chromium v nickel-aluminum) type and shall comply with BS 1041 and BS EN 60584-1.

Thermocouple junctions shall be welded. Ceramic-insulation material may be used for base-metal thermocouples but low-silicon insulation material shall be used for noble-metal thermocouples. Thermocouple systems shall have thermoelectric ice point reference chambers or receivers or amplifiers with automatic cold junction compensation.

Thermocouple receivers and amplifiers shall also have zero and span adjustment, common and series mode interference rejection circuits, radio-frequency filters, input-output circuit isolation and thermocouple break feature whereby the output is driven to zero or full-scale, as stipulated by the Employer Representative, when the receiver or amplifier input circuit is broken.

Thermocouple elements shall be electrically isolated from their sheaths but each terminal head shall have facilities for earthing the thermocouple and for terminating the screen of the extension or compensation cable.
Amplifier chassis shall have facilities both for being earthed to the instrument case via a capacitor and for being electrically isolated from the instrument case.

Temperature transmitters shall be of rugged construction microprocessor based instruments. They shall provide simultaneous digital and analogue outputs and the 4mA to 20mA dc output shall be linear with temperature.

## 13.22 Temperature Switches

Temperature switches shall have contacts with differing 'cut-in' and 'cut-out' values. Their nominal operating points shall be fully adjustable over the whole range of the instrument and the set-value shall be clearly indicated by a dial and pointer.

**Note**: - RTD's of Winding and Bearing Temperatures of Pumps / Motors shall be monitored through Temperature Scanner Indicators.

## 13.23 Strain-gauge Load Cell Weight Indicator and Transmitters

Weight Indicator Transmitter shall comprise of Compression Type Strain Gauge Load Cells along with Transmitter and Indicator for measurement of Sludge Hopper Weight Applications in Sewage Treatment Plant. Strain Gauges shall be mounted on the top and bottom to measure Tension and compression forces.

| | |
|---|---|
| Measuring Range | As per Process Requirement |
| Temperature Range | -30oc to + 80oc |
| Accuracy | +/- 0.5 % of Measured Value |
| Supply Voltage | 24 V DC |
| Output | 4-20mA |
| Indicator Display | Required |

## 13.24 Online Analytical Instrumentation

Online Analytical Instrumentation shall be used to provide continuous monitoring of effluent quality to permit the performance of the sewage treatment plant to be assessed on a continuous basis and to provide early warning of plant malfunction or failure. On a minimum,Online analytical instrumentation shall also be used to monitor functions not related to effluent quality, e.g., digester pH or sludge solids content of sludge for disposal( as applicable).

The monitors and their associated sensors or cells shall be selected as appropriate to the particular application.

In all cases, the location and housing of the monitor shall take into account the provision of a representative sample to the monitor sensor, the pre-conditioning if any, required prior to the sample's analysis, operator requirements for access, maintenance, calibration, repair and replacement of the monitor or its sensors.

All online analytical instruments shall be single channel and shall have individual analyser units only.

**Note:**

***Contractor will include the manufacturer's services to perform start-up on instrument to include basic operational training and certification of performance of the instrument.***

***Contractor will include a manufacturer's Service Agreement that covers all the manufacturer's recommended preventative maintenance, regularly scheduled calibration and any necessary repairs beginning from the time of equipment startup through to SAT acceptance and operation & maintenance period.***

***The above are to be performed by manufacturer's factory-trained service personnel only. Field service and factory repair by personnel not employed by the manufacturer is not allowed. Manufacturer's service parts and reagents shall be used. Third-party parts and reagents shall not be accepted and used.***

**Online Turbidity Measurement:**

Online sensor shall be based on Nephelometric measuring principle with 90deg scattering light method as per ISO 7027.The sensor shall be of plug and play type with digital communication .The sensor shall be with IP68 rating suitable for measuring range 0 to 9999 FNU /NTU with accuracy of <2% of measured value or 0.1 FNU/NTU.

The sensor shall store on-board all the calibration data and other diagnostic information. On a minimum, the sensor shall have provision to store at-least 5 user calibration points.

The transmitter shall be suitable for outdoor installation with IP67 rating.

| | **Transmitter** | |
|---|---|---|
| 1 | Transmitter Type | Four wire |
| 2 | Output | 4-20 mA HART current, instrument diagnostic |
| 3 | Supply voltage | 100 / 115 / 230 V AC +10 / –15%, |
| 4 | Material | Field Housing : Polycarbonate |
| 5 | Display | LC display, two lines, with status indicators<br>Graphic display : backlit ; transflective display ; user settable measuring menus ; red display for alarms |
| | | |
| 6 | Electromagnetic compatibility | interference emission and interference immunity acc. to EN 61326-1:1998 |
| 7 | Protection class of field housing | IP 67 |
| 8 | Ambient temperature | –20 ... +60 °C |
| 9 | Self-Diagnostic feature | Required |
| | **Sensor** | |
| 10 | Type | Turbidity |
| 11 | Principle | Nephelometric measuring principle 90° NIR scattered light according to ISO 7027 / EN 27027 |
| 12 | Measuring wavelength and range | 860+/- 30nm<br>0..9999 FNU, 0..150g/l SS |
| 13 | Material | Sensor shaft : Stainless Steel 1.4404(AISI 316L)<br>Optical window- Sapphire<br>O-ring- EPDM |
| 14 | Max Process temperature | 50°C |
| 15 | Max Process pressure | 10bar |
| 16 | temperature sensor | Integrated NTC temperature sensor |
| 17 | Connection | Fixed cable connection |
| 18 | Ingres protection | IP68 |
| 19 | Additional Certifications | Required |

| | | |
|---|---|---|
| 20 | Resolution | 0.001 FNU, 0.01 ppm, 0.1 g/l, 0.1% |
| 21 | Measurement error | <2% of meas. value (min. 0.02 FNU) |

**Online pH Measurement:**

The p H online analytical instrumentation sensor shall be based on potentiometric measurement using glass sensor. The system shall comprise a combination pH sensor with integral reference electrode and temperature compensation, cabling, sensor mounting and a converter.

Sensors shall be either dip probe, flow cell or insertion types whichever is appropriate.
Dip probes shall be mounted on a floating or fixed corrosion resistant bracket. Insertion type sensors shall be removable without the need to drain down or shut down the process. Mounting of all sensors shall be arranged to prevent fouling and to allow easy access for removal for maintenance, cleaning and calibration.

Where the sensor is likely to be subject to poisoning, e.g. in an anaerobic situation where sulphide may occur, the sensor type shall be selected to be resistant to poisoning, e.g. by the provision of a double junction electrode. The sensor shall function over the pH range 0 to 14.

The system response time shall be not greater than 15 seconds for pH systems used for control and not greater than three minutes for monitoring only systems for 90% change in each case.

Overall accuracy shall be ±0.2 pH with a repeatability of ±0.1 pH. The sensor shall have digital communication based on inductive energy transfer; the sensor shall have inbuilt memory to store calibration data, and other additional diagnostic information. The transmitter shall be suitable for outdoor installation with IP67 rating.

| | **Transmitter** | |
|---|---|---|
| 1 | Transmitter type | Four wire |
| 2 | Output | 4-20 mA HART current, instrument diagnostic |
| 3 | Supply voltage | 100 / 115 / 230 V AC +10 / –15%, |
| 4 | Material | Field Housing : ABS Polycarbonate non corrosive |
| 5 | Display | LC display, two lines, with status indicators<br>Graphic display : backlit ; transflective display ; user settable measuring menus ; red display for alarms |
| 6 | Electromagnetic compatibility | Interference emission and interference immunity acc. to EN 61326: 1997 / A1: 1998 |
| 7 | Protection class of field housing | IP 67 |
| 8 | Ambient temperature | –20 ... +60 °C |
| 9 | Diagnostic feature | Required |
| | **Sensor** | |
| 10 | Type | Glass electrode |
| 11 | Principle | Glass electrode Teflon diaphragm |
| 12 | Measurement range | 0 - 14 pH |

| | | |
|---|---|---|
| 13 | Material | Glass |
| 14 | temperature sensor | NTC / Pt100 |
| 15 | Connection | Inductive digital connection with Transmitter |
| 16 | Ingres protection | IP68 |
| 17 | Resolution | 0.01pH, Temp 0.1°C |
| 18 | Calibration | Sensor to store calibration data , min/max pH range , Temperature |
| 19 | Measurement Error | ± 0.5% of Measuring range |

**Online Chlorine Measurement:**

Online chlorine analyser shall be based on Amperometric based measurement of active chlorine converted to free chlorine by means of pH compensation. The sensor shall have digital communication based on inductive energy transfer which will withstand moisture, corrosion and ensure reliable data transmission at all times.

The offered transmitter shall be IP67, Interference emission & immunity shall be as per EN 61326-1:2006.

| | **Transmitter** | |
|---|---|---|
| 1 | Measuring parameter | Free Chlorine / Residual Chlorine |
| 2 | Transmitter type | 4- wire |
| 3 | No of channel | Two channel ( one for chlorine , one for pH) |
| 4 | Output | 4-20 mA HART current , instrument diagnostic |
| 5 | Supply voltage | 100 / 115 / 230 V AC +10 / –15%, 48 ... 62 Hz |
| 6 | Material | Field Housing : ABS / Polycarbonate |
| 7 | Display | LC display, two lines, with status indicators<br>Graphic display : backlit ; transflective display ; user settable measuring menus ; red display for alarms |
| 8 | Electromagnetic compatibility | Interference emission and interference immunity acc. to ISO EN 61326: 1997 / A1: 1998 |
| 9 | Protection class of field housing | IP 67 |
| 10 | Ambient temperature | –20 ... +60 °C |
| | **Sensor** | |
| 11 | Principle | Amperometric measurement of free chlorine / Residual Chlorine with pH compensation |
| 12 | Measurement range | 0,01 - 5ppm free chlorine |
| 13 | Material | Sensor shaft : PVC |
| | | Membrane : PTFE |
| | | Membrane cap :PBT (GF30); PVDF |
| 14 | pH compensation | pH sensor for compensation required |

| | | |
|---|---|---|
| 15 | temperature sensor | NTC / Pt100 |
| 16 | Connection | Inductive digital connection with Transmitter |
| 17 | Ingres protection | IP68 |
| 18 | Resolution | 0.01mg/l |
| 19 | Repeatability | +/- 1 % |
| 20 | Measurement Error | 1 % of measured value |
| 21 | Mounting | Flow assembly |

The residual chlorine analyzer shall continually measure the concentration of free chlorine residual present and, by control of the chlorine dosage rate, shall maintain the predetermined concentration. The residual analyzer shall have the capability to initiate high and low alarm locally and to SCADA.

**Online Dissolved Oxygen Measurement:**

The online dissolved oxygen monitor shall comprise a dissolved oxygen sensor, cabling, sensor mounting and a converter. The sensor shall be provided with a suitable mounting either floating or fixed to locate the sensor in the required position. The mounting shall be specially designed to prevent fouling of the sensor and to permit easy access and removal of the probe for maintenance, cleaning and calibration. Where the sensor is to be sited in a hazardous area, it shall be certified as suitable for use in that area, according to its classification.

The system response time shall be not greater than 40 seconds for control applications and not greater than 3 minutes for monitoring only.

Accuracy shall be 0.01 mg/L or +/- 1% of measured value. This performance shall be maintained without manual intervention for a period of not less than 30 days. Auto calibration or auto cleaning techniques may be utilised to meet this requirement.

If auto cleaning is incorporated it shall not affect the accuracy of the instrument for a period greater than 5 minutes in any hour for a 40 second response system and 15 minutes in any hour for a 3 minute response system.

The converter shall be mains powered and suitable for wall mounting in a local enclosure or for door mounting within an MCC common control section. It shall include a digital display with manual selection of dissolved oxygen as mg/l or % saturation, and temperature in $^{o}$C.

The range shall be selected manually. The controller shall include high and low set point control functions and high and low alarm functions. It shall also provide an output suitable for PLC system.

Automatic and manual calibration facilities shall be provided.

| | |
|---|---|
| Measuring principle | Optical type |
| Measuring Range | 0-20mg/l ( 0-20ppm) |
| Temperature compensation | Required |
| Operating temp range | –5 to 60 °C (20 to 140 °F) |
| Accuracy | 0.01 mg/L or +/- 1% of measured value |
| Repeatability | +/- 0.5% of measuring range |

| | |
|---|---|
| Sensor material | Sensor shaft : Stainless steel 1.4571 (AISI 316Ti)Cap: POM.Fluorescence layer : Silicone |
| Temperature compensation | Required , internal |
| Cable/connector IP rating | IP 68 |
| Sensor signal output | Digital communication with transmitter , instrument diagnostic |
| Sensor memory | Required to store - calibration data, sensor model, serial number etc |
| Power Supply | 100 to 230Vac +/- 15%, 50/60 Hz |
| Measuring signal input | Digital input from sensor |
| Measuring Range | To fit sensor range |
| Display | Graphic display : backlit ; transflective display ; user settable measuring menus ; red display for alarms |
| Enclosure IP rating | IP67, NEMA 4X |
| Enclosure material | Polycarbonate |
| Electromagnetic Compatibility | Interference emission & immunity as per EN 613261:2006, class A for industry |

**Online Suspended Solids Measurement**

The method of measuring turbidity and suspended solids shall be with a dual-beam infrared/scattered light photometer. Other methods of turbidity and suspended solids measurement, such as four-beam or surface scatter methods, are not acceptable.

A) Performance Requirements
1) Measurement range
a) Turbidity: 0.001 to 4000 NTU
b) Suspended solids: 0.001 mg/l to 50 g/L
2) 2. Accuracy
a) Turbidity: <1% of reading or ±0.001 NTU, whichever is greater
b) Suspended solids: Less than 5% of reading
3) Repeatability
a) Turbidity: Less than 1% of reading
b) Suspended solids: Less than 3% of reading
4) Detection limit
a) Turbidity: 0.001 NTU
b) Suspended solids: 0.001 mg/L
5) Response time: Initial response 1 second
6) Units of measure:
a) Turbidity: User Selectable NTU, FNU, EBC, FTU and TE/F
b) Suspended Solids: User Selectable g/L, mg/L, ppm, or % solids

B) Operational Criteria
1) Sample flow velocity: 3 m/s maximum
2) Sample pressure: 6 bar maximum

The sensor shall provide sample color-independent measurement. The sensor shall be equipped with a self-cleaning device to prevent erroneous values and maintenance problems caused by biological activity, scum build-up, and gas bubbles. The sensor shall measures turbidity and suspended solids.

**Online Phosphate Measurement:**

Online Phosphate measurement shall be based on Colorimetric principle as Molybdenum blue method as per DIN EN1189 / Molybdate vanadate method. The analyzer shall have auto calibration and auto cleaning facility

| | |
|---|---|
| Measuring Principle | Colorimetric |
| Method | Photometric orthophosphate measurement based on Molybdenum blue method as per DIN EN1189 / Molybdate vanadate method |
| Measurement range | 0.05 to 2.5 mg/l PO4-P - Molybdenum blue method |
| | 0.05 to 10 mg/l PO4-P - Molybdenum blue method |
| | 0.5 to 20 mg/l PO4-P – Molybdate yellow method |
| | 0.5 to 50 mg/l PO4-P – Molybdate yellow method |
| No. of measuring channel | 1 channel |
| Accuracy | +/- 2 % of full scale |
| Repeatability | +/- 2% of display value +0.01mg/L |
| Calibration | Auto calibration |
| Power Supply | 115 V AC / 230 V AC, 50/60 Hz |
| Output | 2 X 0/4 ... 20 mA |
| Enclosure | IP55 |
| Electrical safety and | IEC 61010-1 Class I equipment , Interference immunity as per EN61326-1:2013 |
| Electromagnetic compatibility | Interference immunity as per EN61326-1:2013 |
| Auto cleaning facility | In-built |

**Online Nitrate Measurement:**

Online sensor shall be based on organic substance measurement on absorbance measurement at wavelength at UV254nm.The offered sensor shall not have any sampling or conditioning system, without any chemical requirements

Sensor output shall be in digital format for reliable and long distance transmission without loss of signal due to moisture or water

The transmitter shall be suitable for outdoor installation with IP67 rating.

| | |
|---|---|
| Measuring principle | Optical sensor based on UV absorption method; measurement at 254 nm without any sampling /conditioning requirements |
| Sensor type | Direct probe type in-situ mounting without any regent 3for |

| | |
|---|---|
| | operation |
| Process temperature | 5 - 50°C (41 -120°F) |
| Absorption wavelength | 190-230nm |
| Reference wavelength | 254nm |
| Process pressure | 0.5 to 10 bar (7 to 145 psi) absolute |
| Ambient temperature | -20 to 60°C / -4 - 140°F |
| Sensor Ingress Protection rating | IP 68 |
| Maximum measured error | 2 % of full scale |
| Measuring range | 0.1 to 50mg/L of NO3-N |
| | 0.01 to 20mg/L of NO3-N |
| Repeatability | +/- 2 mg/l NO3-N |
| Drift | Less 0.2 % of end of measuring range per week |
| Sensor signal output | Digital communication with transmitter |
| Power Supply | 100 to 230Vac +/- 15%, 50/60 Hz |
| No. of measuring channels | * 1 or 2 channel /Multichannel |
| Measuring Range | To fit sensor range |
| Display | Graphic display : backlit ; transflective display ; user settable measuring menus ; red display for alarms |
| Enclosure IP rating | IP67, NEMA 4X |
| Electromagnetic Compatibility | Interference emission & immunity as per EN 61326-1:2006, class A |

**Online TOC Measurement:**

Online sensor shall be based on organic substance measurement on absorbance measurement at wavelength at UV254nm, using potassium hydrogen phthalate as organic reference. The offered sensor shall not have any sampling or conditioning system, without any chemical requirements. Sensor output shall be in digital format for reliable and long distance transmission without loss of signal due to moisture or water

The transmitter shall be suitable for outdoor installation with IP67 rating.

| | |
|---|---|
| Measuring principle | UV photometric - SAC [Spectral absorption coefficient]method; measurement at 254 nm without any sampling /conditioning requirements |
| Sensor type | Direct probe type in-situ mounting without any regent for operation |
| Process temperature | 5 - 50°C (41 -120°F) |
| Process pressure | 0.5 to 10 bar (7 to 145 psi) absolute |
| Ambient temperature | -20 to 60°C / -4 - 140°F |
| Sensor Ingress Protection rating | IP 68 |

| | |
|---|---|
| Measuring range | TOC : 0 to 410mg/L |
| Maximum measured error | 2 % of upper end of measuring range |
| Repeatability | 0.5 % of end of measuring range |
| Drift | Less 0.2 % of end of measuring range per week |
| Sensor type | Digital sensor communication with transmitter |
| Chemical | Chemical free measurement |
| Automatic cleaning | Air cleaning |
| Power Supply | 100 to 230Vac +/- 15%, 50/60 Hz |
| No. of measuring channels | 1 channel |
| Display | Graphic display : backlit ; transflective display ; user settable measuring menus ; red display for alarms |
| Enclosure IP rating | IP67, NEMA 4X |
| Electromagnetic Compatibility | Interference emission & immunity as per EN 61326-1:2006, class A |

**Online TDS measurement:**

| | |
|---|---|
| Measuring principle | Conductivity |
| Measuring Range | 0.01 - 20 mS/cm |
| Temperature compensation | Required |
| Operating temp range | -20 to +135 °C |
| Pressure range | 16bar max |
| Cable/Cable connector type | Plug in head |
| Cable/connector IP rating | IP 68 |
| Cable length | 15 mtr minimum |
| Sensor signal output | Digital communication with transmitter |
| Sensor memory | Required to store - calibration data, sensor model, serial number etc. |
| Sensor diagnostics | required |
| Power Supply | 100 to 230Vac +/- 15%, 50/60 Hz |
| No. of measuring channels | 1 channel |
| Measuring Range | To fit sensor range |
| Enclosure IP rating | IP67, NEMA 4X |
| Electromagnetic Compatibility | Interference emission & immunity as per EN 61326-1:2006, class A for industry |

**Online ORP Measurement:**

| | |
|---|---|
| Service | Measurement of Oxidation Reduction Potential |
| Repeatability | ± 20 mV |

| | |
|---|---|
| Range | -2000 – 2000 mV/-1500 to + 1500 mV |
| Sensor | |
| Type | Immersion Type |
| Mounting | Locally |
| Installation hardware and Integral cable | Required |
| Probe material<br>Operating temperature range<br>Digital Sensor<br>Pressure range<br>Type of Ground Electrode | Suitable for Sewage application<br>Analog Sensor: - 5 to 105 deg C<br>- 5 to 70 deg C<br>0 to 6.9 bar<br>Titanium ground electrode to eliminate ground Loop currents in the measuring electrodes. |
| Sensitivity | =/- 0.5 mV |
| Stability | 2 mVper 24 Hours, non-cumulative |
| Flow rate | 3 m (10feet) per second maximum |
| Built in temperature element | NTC 300 ohm thermistor for analyzer temperature Readout |
| Sensor Cable | 4 conductor cable with one shield and polyurethane jacket rated to 105 deg C |
| **Transmitter** | |
| Type | Microprocessor Based having back Lit LCD display |
| Mounting | Field |
| Prefabricated integral cable for connecting sensor and transmitter | Required |
| Analog outputs | 4–20 mA |

## 13.25 All Weather Refrigerated Auto samplers

The contractor shall provide an all-weather refrigerated auto sampler's (2 Nos) with all required sample containers (at least 5 nos, comprising of all sizes available), reagents, media (as applicable) for the representative collection of samples to monitor influent and effluent waters individually from the sewage treatment plants The auto samplers shall be suitable for indoor and outdoor use. The equipment shall be UL certified.

The method of sample collection shall be via high-speed peristaltic pump for collection of the sample liquid.

Performance Requirements

1) Sample cooling: maintain sample liquid at 4°C (39°F) in ambient temperature to 50°C (122°F) maximum; accurate to ±0.8°C (±1.5°F).
2) Sample volume: shall be programmable in 10 mL increments from 10 to 10,000 mL.
3) Sample volume repeatability ±5% of 200 mL sample volume with: 4.6 m (15 ft.) vertical lift,
4) Sample volume accuracy: ±5% of 200 mL sample volume with: 4.6 m (15 ft.) vertical lift
   Operational Criteria
5) Operating temperature: 0 to 50°C

6) Storage temperature: -30 to 60°C

The auto samplers shall be interfaced with the plant main PLC system for complete monitoring of the auto sampler system parameters, control & monitoring from the PLC system.

The Auto sampler shall be Fully automatic, stationary sampler for discontinuous time, flow (CVVT) and event-proportional sampling based on vacuum principle.

Housing:

Shall be made of double-walled stainless steel 304 with 40 mm insulation and insulated stainless steel roof. Double door sealing (door and cabinet) shall be provided to prevent cold bridges.

The auto sampler housing shall be divided into:

1. Lower part of the cabinet for storing the samples (sample storage cabinet).
2. Upper part of the cabinet divided into three separate compartments for electronics (IP 65 protected), compartment for pumps and valves (IP 65 protected) and compartment for cooling machine with possibility to connect an external air supply.

Thermostatic Control
The sampler shall have Frost protection heating system with over temperature protection.
Adjustable fully automatic and manual defrosting facility shall be provided as integral part of the equipment.

Sampling System
Pressure-vacuum sampling system for time, flow (CVVT) and event proportional sampling shall be provided.
Metering vessel made of borosilicate glass for single samples from 12 to 200 ml shall be included.
Multiple shots per sample for larger sample volume shall be adjustable by software and shall be demonstrated.

Pump
Standard pump: 230 V AC, air capacity 14 l/min, pressure 1 bar, vacuum -0.8 bar, lift height up to 8 m.
Motorized pinch valve with adjustable closing force shall be provided.

Communication:

The equipment shall provide the following i/p to the control system as diagnostic feature:

- general error alarm
- bottle change (distributor travel i/p)
- sample taken (pulse for every sample)
- program running
- end of program
- voltage return after power loss
- Access surveillance via door switch i/p.( When door is opened, program is suspended; when door is closed, program resumes)

- Special coating of copper parts of the cooling unit
- The complete cooling unit (incl. compressor, tubes etc.) shall be coated for protection against aggressive ambient conditions; including additional insulation of electronics of cooling unit. Certificate for the same shall be provided.

## 13.26 Laboratory Instruments and LIMS system

The laboratory shall be equipped with LIMS software, Lab instruments, equipment, chemicals and other infrastructure that is necessary to perform the routine analysis for the parameters as detailed in table below.

STP Contractor shall submit the complete list of lab equipment required for full analysis of parameters to the employer's representative for approval. Contractor shall include in his offer supply of chemicals required for analysis along with proposed lab instruments and associated equipment, including for the O&M period as specified elsewhere in the bid document.

**Minimum list Laboratory equipment to be provided are detailed as below**:

| Item No | Description | Unit | Quantity |
|---|---|---|---|
| 1 | Comparator test set for residual chlorine or chloroscope | No. | 1 |
| 2 | Multi Parameter (pH and Conductivity Meter) | No. | 1 |
| 3 | Mains operated pH meter completed with one calomel electrode and glass electrode | No. | 1 |
| 4 | Turbidimeter - Bench Model (Nephelometric Type) | No. | 1 |
| 5 | Turbidimeter - Hand held (Portable) | No. | 1 |
| 6 | Spectrophotometer | No. | 1 |
| 7 | Water bath with 6 to 8 concentric holes and discs, electrically heated | No. | 1 |
| 8 | Soxhlet extraction unit | No. | 1 |
| 9 | Kjeldahl digestion unit | No. | 1 |
| 10 | Hot plates | No. | 10 |
| 11 | Distilled water plant | No. | 1 |
| 12 | Demineraliser | No. | 1 |
| 13 | Refrigerator (320 litres capacity) double door | No. | 1 |
| 14 | B.O.D. incubator | No. | 1 |
| 15 | Muffle furnace | No. | 1 |
| 16 | Electric oven | No. | 1 |
| 17 | Magnetic stirrer | No. | 1 |
| 18 | Monopan balance with digital display | No. | 1 |
| 19 | Jar-Test apparatus with RPM controller and simultaneous addition of Chemicals in all jars | No. | 1 |
| 20 | Centrifuge | No. | 1 |
| 21 | Gas cylinder if gas supply is not available | No. | 1 |
| 22 | Fume cupboard/hood | No. | 2 |
| 23 | Field Test kit for cations and anions | No. | 2 |
| 24 | Depth sampler | No. | 2 |

| Item No | Description | Unit | Quantity |
|---|---|---|---|
| 25 | Online Total organic carbon analytical analyser with online feedback to LIMS and SCADA system | No. | 1 |
| 26 | Sieve shaker with standard sieves and Two pan balance, weighing up to 200gm samples | No. | 1 |
| 27 | Electronic Weighing Balance (Max. 10 kg) | No. | 1 |
| 28 | Durham tubes and Imhoff cones (1 lot) | lot | 1 |
| 29 | D.O meter | No. | 1 |
| 30 | Specific Gravity Meter (1.0~1.1 and 1.2~1.3) | No. | 1 |
| 31 | Consumables – disposable & reusable type | No. | 1 |
| **Equipment Needed For Bacteriological Examination** | | | |
| 30 | Hot Air Oven | No. | 1 |
| 31 | Autoclave | No. | 1 |
| 32 | Incubator 37°C or 44°C (Water/Air-Jacketed) | No. | 1 |
| 33 | Binocular microscope | No. | 1 |
| 34 | Digital pH Meter | No. | 1 |
| 35 | Pipette Box (Stainless Steel) | No. | 10 |
| 36 | Wooden Racks/Aluminum Racks | No. | 5 |
| 37 | Wire Baskets | No. | 10 |
| 38 | Cotton/ Aluminum Foils | No. | 10 |
| 39 | Burners (Bunsen) With Pilot Lamp | No. | 3 |
| 40 | Suction Flask (1 Litre Cap) | No. | 2 |
| 41 | Suction Pump | No. | 1 |
| 42 | Sampling Bottles | No. | 10 |
| 43 | Measuring Cylinders (1000 Ml, 500 Ml, 200 Ml, 100 Ml, 50 Ml, 25 Ml) | Set | 3 |
| 44 | Vacuum pump | No. | 1 |
| **Bacteriological Media** | | | |
| 45 | M. Endo Broth (dehydrated) | No. | 1 |
| 46 | Lactose or Lauryl Tryptose broth | No. | 1 |
| 47 | Mac Conkey broth | No. | 1 |
| 48 | Brilliant Green Bile Lactose Broth | No. | 1 |
| 49 | Total Plate Count Agar | No. | 1 |
| 50 | Peptone/Triyptone Water | No. | 1 |
| 51 | Laminar Air Flow Chamber | No. | 1 |

The above indicated lab instruments are the minimum equipment to be provided at each STP. If as per process requirements, any additional equipment is required, the contractor shall supply the same at no additional cost.

The equipment shall be supplied with all the accessories that are necessary to make the equipment functional for analyzing parameters. Contractor shall include any additional equipment if necessary under his scope of work.

## A. Laboratory Information Management software (LIMS):

The LIMS Software shall be installed pre-configured with regulatory, process, and other variables. The system shall be "user friendly" and shall use standard "Windows" conventions. The system on a minimum store plant data and provide reports and graphs for analysis and control. Database software as required shall be provided by the contractor.
Licensing for concurrent client users and multiple facility support shall be included.

The contractor shall include a computer hardware system as detailed in the specifications elsewhere. Operating system software shall be latest by Microsoft to suit the application software and onward connectivity to the plant SCADA system.

A full audit trail of all inserts, edits, deletes, and approvals shall be provided for all data points and system parameters. The system shall provide security features to ensure that only authorized individuals enter, view and modify data. Access levels shall be definable to restrict use of system level functions (such as user authorization), and to provide data access levels to restrict the use of data entry, data approval, data retrieval, data modification, database structure creation or modification functions.

**Functionality**
The software shall make available an unlimited number of user defined variables whose values may be defined as daily, hourly, 15-minute, or 1-minute parameters.
Text parameters and calculations shall be available. These calculated data values shall be stored in the database thus ensuring the consistency of the data and allowing the same data to be readily available for analysis. Historical equations shall allow definitions of the calculation by date.

Program shall store an unlimited number of user defined custom data entry forms or bench sheets with text and variables (one or more days) positioned as desired. Variable name, units, entry range, and permit limits shall be displayed when entering data to increase data accuracy.
An audible-visual prompt will activate when value is outside a specified range.
The software shall provide unlimited daily comments and comments attached to a sample value.
The software shall contain a complete statistical analysis capability including mean, variance, standard deviation, max and min, and confidence interval for any parameter in the Data Manager.
Trend charts shall be quickly and easily available for any variable.
The LIMS software shall be interfaced/integrated with the plant SCADA Historian for automatic collection of summarized data from historical file(s) as per requirement. The integration shall run with no user intervention.

## B. Laboratory Equipment:

### 1) UV Visible Pre-programmed Spectrophotometer:

UV Visible Pre-programmed Spectrophotometer for measurements of water Quality parameters and Spectral Analysis Shall be pre-programmed for more than 200 preprogrammed tests and special methods, 100 user defined methods, concentration, absorbance, transmission, factor, kinetics, 2-point calibration, scan, nephelometric turbidity measurement, different color measurement scales common drinking water testing parameters like residual chlorine, Iron, Hardness, alkalinity, fluoride and sulfate etc. The spectrophotometer instrument shall be a multi-wavelength, UV-Visible, single beam spectrophotometer

designed for Water analysis. The instrument, depending on the test selection, shall automatically select the wavelength.

Readout modes shall include transmittance, absorbance, concentration, optional wavelength scan and time course graphs. Spectrophotometer should come along with the following reagents and accessories**:** Power supply, Operators manual, one pair 10mm rectangular path length cells and reagents for common drinking water parameters like residual free chlorine, Iron, sulfate, silica Low range and Fluoride for 1000 tests.

**Technical Specifications:**

| **Technical specifications of UV-Visible spectrophotometer** | |
|---|---|
| Type: | Spectrophotometer with reference detector technology (RDT) |
| Light sources: | Halogen lamp (visible range) Deuterium lamp (UV range) |
| Optical system: | Monochromator |
| Wavelength range: | 190 nm–1100 nm |
| Wavelength accuracy: | ± 1 nm |
| Wavelength resolution: | 0.1 nm |
| Wavelength calibration: | Automatic ,Instrument should have inbuilt Holmium oxide filter |
| Wavelength selection: | Automatic, barcode, manual |
| Scan speed: | 1 complete scan < 1 min |
| Spectral bandwidth: | < 2 nm |
| Photometric range: | ± 3 Abs |
| Photometric accuracy: | 0.005 Abs at 0.0–0.5 Abs; <1% at 0.5–2.0 Abs |
| Photometric linearity: | < 0.5% at 2 Abs; <1% at >2 Abs |
| Stray light: | < 0.05 % |
| Measuring modes: | More than 200 preprogrammed tests and special methods, 100 user defined methods, concentration, absorbance, transmission, factor, kinetics, 2-point calibration, scan, nephelometric turbidity measurement, different color measurement scales |
| Turbidity measurement: | Nephelometric turbidity measurement, 0.1–1000 NTU, instrument should have separate optics for turbidity measurement.<br>Turbidity must be measured and shown for preprogrammed tube tests and customized methods in tubes and shown together with the result of the measurement to account for interfering turbidities (nephelometirc turbidity) |
| Preprogrammed special methods | Measurement of nitrate and SAC in UV range; nephelometric turbidity and TSS |
| Inspections equipment monitoring (IQC) | Instrument must have a preinstalled Holmium oxide filter to automatically check for wavelength accuracy.<br>Control of lamps, photometric correctness and stray light.<br>Measurement of standards, spike additions, multi determinations and dilutions |
| Color measurements | CIE conform color measurements must be possible, Measurement of color according to ISO7887 B,C ,APHA/HAZEN/PT-CO, ASTM 209,GARDNER,SAYBOLT |

| | |
|---|---|
| | (ASTM D156 ASTM 6045),Hunterlab, ASTM D1500,ICUMSA ,EP (Phr Eur) ,mgl2,Hess-Lves and Spectral data |
| User programs | 100 |
| Cuvette slot: | Universal cuvette slot for:<br>Test tubes 16 mm OD<br>Rectangular cuvettes 2 mm, 10 mm, 20 mm, 40 mm and 50 mm |
| Data memory: | Internal Micro SDHC card, 5000 measured data sets, 100 spectra, GLP conform<br>(result, date, time, operator, dilution, comment, sample ID) |
| Display | HD 10 inch, anti-reflective cover glass with projected<br>capacitive touch screen (PCAP) |
| Operating range: | 10–40 °C, max. 80 % relative humidity (without condensation) |

**2) Laboratory pH Meter:**

| pH meter Technical Specifications | |
|---|---|
| Measurement Method | pH : Glass electrode method<br>Temperature: Thermistor resistor |
| Display unit | Large Screen display<br>Various display functions:<br>Vertical/Horizontal screen switchable<br>Graphic Display<br>Easy-to-read menu<br>Touch panel input<br>Maintenance information |
| Measurement Item/Range | pH:0.000 - 14.000<br>Temperature: 0.0 - 100.0°C |
| Display Range | pH: pH-2.000 - 16.000<br>Temperature: -5 - 110.0°C |
| Display resolution switch | pH: 0.01pH/0.001pH<br>mV ( ORP): 1mV |
| Repeatability(Main body) | pH: ±0.006pH<br>mV( ORP): ±2mV<br>Temperature: within ±0.2°C |
| pH Temperature Compensation Range: | ATC(Auto Temperature Compensating): 0 - 100.0 °C<br>MTC(Manual Temperature Compensating):0 - 100.0°C |
| pH Calibration: | JIS pH standard solution, US standard solution, customized standard solution, Max. 5 point calibration |
| Temperature Calibration | 1 point calibration |
| Performance Guaranteed Temperature, Humidity | 0 - 45°C, 20 - 85% or below(condensation-free) |
| Auto Hold Function Facility | Instrument should have auto hold function |
| Calibration History Creation Function | Latest one run |
| Interval measurement | Required |

**3) Bench top Multi parameter meter:**

A multi parameter instrument capable of analysis of pH, ORP, dissolved oxygen, conductivity, TDS, salinity and temperature shall be provided. The instrument shall be capable of a quick response and have an intuitive user interface. The instrument shall have automatic temperature correction/compensation. Downloading and storage of data should be easy and convenient. It shall provide RS-232 interface and shall have a minimum of 150 points recall feature.

**Technical Specifications:**

| Multi-Function Water Quality Technical Specifications | |
|---|---|
| Measuring method: | pH: Glass Electrode Method<br>ORP :Platinum Electrode<br>Ion :Ion Electrode Method<br>Conductivity: AC 2-Electrode Method<br>DO : Diaphram Polarographic Method<br>Temperature : Thermistor Resistor |
| Conductivity Measuring Frequency | 80Hz/3kHz, automatic selection |
| Electrode Inputs | 2ch (pH/ORP/Ion/DO Electrode/Conductivity cell connectable) |
| Display Unit | Touch Panel Color Graphic LCD |
| Display | Selectable 2-ch Simultaneous Display or Single Only Display |
| Measuring Range | pH:0.000-14.000pH<br>mV（ORP）: -2000.0~2000.0 mV<br>Ion: Depends on the sensor<br>Conductivity: Depends on the cell<br>Resistivity: Conversion from conductivity Depend on the cell<br>Salinity: Conversion from conductivity<br>Concentration: Conversion from conductivity<br>TDS: Conversion from conductivity<br>DO: Depends on the electrode<br>Saturation %: Depends on the electrode |
| Temperature: | 0.0~100.0°C<br>DO:0.0~50.0°C<br>Ion: Depends on the sensor (No temperature compensation function) |
| Display Range | pH: -2.000-16.000<br>Temperature: -5-110.0°C |
| Repeatability(main unit): | |
| pH | ±0.02pH |
| mV(ORP) | -2200.0~2200.0 mV |
| Ion(Manual/Auto range switching)<br>(mol/L selectable): | ZOOM OFF<br>0.0 ～ 19.9μg/L, 20 ～ 199μg/L, 0.20 ～ 1.99mg/L, 2.0 ～ 19.9mg/L, 20 ～ 199mg/L, 0.20 ～ 1.99g/L, 2.0 ～ 19.9g/L, 20 ～ 199g/L, 200 ～ 1990g/L<br><br>ZOOM ON<br>0.00 ～ 19.99μg/L, 20.0 ～ 199.9μg/L, 0.200 ～ 1.999mg/L, 2.00 ～ 19.99mg/L, 20.0 ～ 199.9mg/L, 0.200 ～ 1.999g/L, 2.00 ～ 19.99g/L, 20.0 ～ 199.9g/L, 200 ～ 1999g/L |
| Conductivity(Manual/Auto range switching): | 0.0 ～200.0μS/m （0.000 ～2.000μS/cm）<br>0.000 ～2.000mS/m （0.00 ～20.00μS/cm） |

| | |
|---|---|
| | 0.00 ～20.00mS/m （0.0 ～200.0μS/cm）<br>0.0 ～200.0mS/m （0.000 ～2.000mS/cm）<br>0.000 ～2.000S/m （0.00 ～20.00mS/cm）<br>0.00 ～20.00S/m （0.0 ～200.0mS/cm）<br>0.0 ～200.0S/m （0.000 ～2.000S/cm）<br>SI unit (S/m) and conventional unit (S/cm) selectable |
| Resistivity(Manual/Auto range switching): | 0.005 ～2.000 Ω·m （0.5 ～200.0Ω·cm）<br>0.00 ～20.00 Ω·m （0.000 ～2.000kΩ·cm）<br>00.0 ～200.0 Ω·m （0.00 ～20.00kΩ·cm）<br>0.000 ～2.000kΩ·m （0.0 ～200.0kΩ·cm）<br>0.00 ～20.00kΩ·m （0.000 ～2.000MΩ·cm）<br>00.0 ～200.0kΩ·m （0.00 ～20.00MΩ·cm）<br>0.000 ～2.000MΩ·m （0.0 ～200.0MΩ·cm）<br>0.00 ～20.00MΩ·m （0 ～2000MΩ·cm）<br>SI unit (Ω·m) and conventional unit (Ω·cm) selectable |
| Salinity: | 0.00 ～ 4.04%（NaCl）<br>0.00 ～ 42.40psu (PSS: Sea water salinity) |
| Concentration(Auto range switch): | 0 ～ 2.000%, 0 ～ 20.00%, 0 ～ 200.0% |
| TDS(Manual/Auto range switching): | 0 ～ 99.99mg/L, 0 ～ 999.9mg/L, 0 ～ 9.999g/L, 0 ～ 99.99g/L, 0 ～ 999.9g/L |
| Dissolved Oxygen: | 0.00 ～ 22.00mg/L<br>(High range membrane set (Option) 0.00 ～ 55.0mg/L) |
| Saturation %: | 0 ～ 220.0%<br>(High range membrane set (Option) 0 ～ 550%) |
| Temperature: | -5.0 ～ 110.0°C |
| Display Resolution Switching: | pH: 0.01pH/0.001pH<br>mV: (ORP) 1mV/0.1mV<br>Ion: 0.0μg/L～1990g/L (Maximum to 3 digits)<br>0.00μg/L～ 1999g/L (Maximum 4 digits) |
| Repeatability( Main body unit): | pH: ±0.002pH<br>mV( ORP): ±0.2mV<br>Ion: ±0.5% FS<br>Conductivity: ±0.5% FS<br>Resistivity: ±0.5% FS<br>Salinity: ±0.5% FS<br>Concentration: ±0.5% FS<br>TDS: ±0.5% FS<br>Dissolved Oxygen: ±0.03mg/L (Standard membrane)/±0.1mg/L (High range membrane)<br>Saturation %: ±1% (Standard membrane/High range membrane)<br>Temperature :within ±0.2 |
| Temperature compensation: | pH Temp. compensation<br>range: ATC（Auto Temperature Compensation）: 0 ～100.0°C<br>MTC(Manual Temperature Compensation): 0 ～100.0°C<br>Conductivity Temp. compensation<br>Range: |

| | |
|---|---|
| | ATC(Auto Temperature Compensation): 0- ～100.0°C<br>MTC(Manual Temperature Compensation):0 ～100.0°C<br>Dissolved Oxygen Temperature<br>Compensation Range : ATC(Auto Temperature Compensation): 0 ～ 50.0°C |
| pH calibration | JIS pH Standard Solution, US Standard Solution,Custom Standard Solution, Max. 5-point Calibration |
| Ion calibration | Max.5-point Calibration |
| DO calibration | Auto Calibration（ Zero Span Calibration） |
| Temp. calibration: | 1-point Calibration |
| Conductivity Concentration Conversion Setting: | 2-10 points |
| Data Memory: | 2000 data each channel |
| Analog Output: | pH:±700mV (pH0 ～ 14)<br>mV(ORP): ±1V(0 ～ ±2000mV)<br>Ion: 0 ～ 1VFS<br>Conductivity/Resistivity/Salinity/Concentration/ TDS: 0 ～ 1VFS<br>DO/Saturation: 0 ～ 1VFS<br>Range(Ion/Conductivity/Resistivity/Salinity/ Concentration/TDS):100mV/Range<br>Temperature: 0 ～1V(0 ～100°C) |

**4) Laboratory Turbidity Meter:**

Turbidity meter shall have pre-programmed features for measurement of turbidity with ratio color correction covering the range from 0 to 10,000 NTU with auto signal averaging. Turbidity meter should come along with the following accessories: A complete set of calibration standards (0.02, 10, 100, 1750 NTU), Two measuring corvettes with light shield caps, operators' manual, and plug in power adaptor.

**Technical specifications:**

| | | |
|---|---|---|
| 1 | Principal of operation | Nephelometric |
| 2 | Light Source | Infra-red |
| 3 | Extended auto ranging | up to 10,000 NTU<br>0 - 2,450 EBC<br>0 - 10,000 FNU<br>0 - 10,000 FAU |
| 4 | Resolution | NTU on lowest range |
| 5 | Accuracy | ± 2% to ±10% of reading (in 3 ranges) |
| 6 | Response time | less than 6 seconds |
| 7 | Sample size | 30 ml |
| 8 | Air purge | connection for external dry air supply |
| 9 | Auto alert calibration prompt. | |
| 10 | Outputs | RS-232 Serial Port |
| 11 | Reusable Calibration Standards | |

| | | |
|---|---|---|
| 12 | Certification | UL, CSA, CE, ISO7027 |

Instrument should have option for connecting flow thru cell.

**5) Portable Turbidimeter**

The integrated algorithm of scattering and transmission not only makes the measurement of low turbidity more stable, but also realizes wide testing ranges for the instrument (low, middle and high measuring ranges. Integrating algorithm of Scattering(90°) and transmission

**Technical Specifications:**

| | |
|---|---|
| Ranges | 0-1000NTU |
| Accuracy | ±5% |
| Drifting | ≤±1.5% |
| Repeatability | ≤1% |
| Resolution | 0.01NTU (0-9.99NTU) 0.1NTU (10-99.99NTU) 1NTU (100-1000NTU) |
| Stray Light | < 0.02 NTU |
| Sample required | 15 ml |
| Detector Silicon | photodiode |
| Storage conditions | -25 to 50 °C（instrument） |
| Operating conditions | 0 to 50 °C; 0 to 90% relative humidity (noncondensing) |

**6) Dissolved Oxygen Meter:**

**Technical Specifications:**

| | | |
|---|---|---|
| Range | : | 0.00 ～ 22.00mg/L |
| Repeatability | : | ±0.03mg/L (Standard membrane |
| Resolution | : | Temperature :within ±0.2 |
| Method | : | Membrane Polarographic |
| Salinity range | : | 0.00 ～ 4.04%（NaCl）<br>0.00 ～ 42.40psu (PSS: Sea water salinity) |
| DO/Saturation | : | 0 ~1VFS |
| Dissolved Oxygen Temperature Compensation Range | : | ATC(Auto Temperature Compensation): 0 ～ 50.0°C |

**7) Residual Chlorine Meter:**

The instrument should be a handy model which should be capable of analyzing three water quality tests. Instrument should be simple to use and should display error messages as and when they occur. The instrument should be pre-programmed to conduct the following tests:

| | |
|---|---|
| Type: | LED photometer with 3 interference filters |
| Wavelengths: | 450 nm, 530 nm, 590 nm |
| Wavelength accuracy: | ± 2 nm, bandwidth at half transmission 10–12 nm |
| Measuring modes: | Pre-programmed tests |
| Cuvette holder: | Tubes 16 mm OD |
| Memory: | 50 results |
| Display: | Backlit graphic display, result with unit |
| Operation: | Self-explanatory menu guidance, plastic foil keypad test selection via parameter lists |
| Power supply: | 3 AA batteries, rechargeable batteries, USB interface; optional internal accu-pack |
| Preprogrammed Methods | chlorine, chlorine dioxide, pH, fluoride and iron |
| Supply | DPD Chlorine reagent for 100 test |

In addition, Instrument should include the following**:** Intransclam packing with reagents for 100 free chlorine tests**,** Crushing rod and 2 test cells. The instrument should be provided with a operations &instructions manual.

**8) Portable Density Meter:**

Type : truly portable measurement, visibility: both indoors and outdoors to be achieved.
Accuracy : ± 0.001 or better
Storage Capacity : above 1000 results.
Multiple sequential measurements shall be possible with the meter. Meter's sample tube is to be dipped directly into the sample for measurement.
Meter shall be Battery Operated; Lithium ion Rechargeable and removable type batteries shall be used. Temperature Compensation shall be an automatic or by using a user-defined temperature correction coefficient.
If required, meter shall have built-in sampling pump and interface to PC for data acquisition & logging,

## 13.27 Associated Lab Equipment:

**Sterilizer, Autoclave:**

**Purpose:** For sterilization of glassware and culture media for bacteriological analysis.

Double wall construction with inner & outer chamber made of Aluminum. Electrically heated by means of superior quality emersion heaters with working pressure 15 PSI. Inner Chamber Size: 550X750mm. Rating: 6.0 KW, Volume: 175litre.

**Balance, Analytical (Electronic):**

**Purpose:** For preparation of standard solutions used in chemical analysis.

**Specifications:** Should be based on E.M.F.C. Technology

Type: Electronic single Pan, Capacity: 200 mg, Resolution: 0.1 mg, Stainless steel weighing pan; Pan Size: 100 mm Diameter, Display: Sharp, Clear LED Display and Standard bi-directional RS232C

interfaces. Multiple weighing Units: Grams & Carat. It should have auto calibration facility, Overload protection and auto zero facility. Balance should come along with Set of certified calibration weights, Voltage stabilizer, Dust proof cover, Operational manual and necessary tools.

**Centrifuge**: Purpose: For separation of suspended matter from suspensions.

**Specifications:**

| | |
|---|---|
| Max. Speed | 20000 RPM, Max. RCF: 34500, Max. Tube size: 100 ml, Max. Capacity: 400 ml. Width: 450 mm, Depth: 470 mm, Weight: 35 kg |
| Connected Load | 0.75 |
| Rotor Angle Head | 8x50 ml |
| Speed regulation | Step less variable speed control. |
| Digital Speed indicator | 1 to 99 minutes digital timer with by-pass switch for infinite time run. |

**Incubator Bacteriological:**

**Purpose:** For incubation in bacteriological analysis

Double walled cabinet. Outer wall should be made of mild steel, inner wall of stainless steel, lagged with a special insulating material. The inside door should be made of glass panel set in a metal frame fitted with a felt gasket and be fastened by a ball catch.

| | |
|---|---|
| Temperature range | °C above ambient to maximum 60°C. |
| Accuracy | ±2°C |
| Size | 600X600X600cm |
| Rating | 1000Watts. |
| Purpose | For cooling and storage of (standard) solution in a laboratory |

| **Specifications:** | |
|---|---|
| Type | Vertical double door |
| Capacity | Approx: 280 litre. |

**Water Bath, General Purpose:**

Purpose: For enhancement of chemical reaction in various analyses and evaporating of water from samples

**Specifications**: Doubled walled construction Fitted with imported thermostat of 30 Deg C to 110 °C Accuracy of +/- 1 DegC.Working Temp. from 5 Deg C above ambient 80 °C made of double wall, stainless steel construction, with glass wool
Capacity: 15 Ltrs

12 holes of 75 mm dia , 2000 Watts

**Ware Purifier, Distillation Unit (Automatic)**
**Purpose:**

**Applications Type III water maker**
Instrumental Analysis & reagent preparation
Feed Water Specifications
TDS : 500 PPM MAX
Fe ,Mn : NIL
Free Chlorine : NIL
Silica : <20 PPM
Inlet Pressure : 0.5 – 2.0 kg/cm
Product Water Specification:
Nominal Flow To Storage Tank:10 Ltr/Hr
Pure Water Resistivity (Tpye II) : >1 MD
Pure Water Conductivity(Tpye II) :1 µS/cm
Turbidity: 1 NTU
Total Organic Carbon (TOC) : <200 ppb

**Rectangular heating Plate with cast Iron top**
Shall be used for continuous heating up to 350ºC. The body shall be of made of P.C.R sheet painted. Attractively with good stove enamel Top rectangular cast iron Plate has insulated elements. To work on 220/230V AC supply
Size (L x B x H):25 x 30 x 15 cm (10”x12”x6”), With E/R

**Water Still Automatic (Wall Type)**
Compete made of S. Steel provided with automatic ejection type emersion heaters to provide pyrogan free water
Capacity: 4 Liters, Load: 4 KW

**Demineraliser**
Two Bed Capacity 100 lt/hr

**Refrigerator--Double Door**
Capacity: 280 Liters

**Muffle Furnace Rectangular**
Light weight with ceramic fibre wool insulation the outer casting shall be made of double walled thick P.C.R.C. sheet Re attached with thick perforated sheet on the bottom portion, painted with attractive stove enamel.

Heating elements shall be made of KANTHAL A1 wire of coil form embedded on the muffle with high grade refectory cement and backed by high temperature cer-wool insulation which avoids loss of energy. The apparatus shall be complete with one pyrometer, thermocouple & silver thermal fuse.

**Laboratory Oven**
Double walled construction. Inner chamber made of Aluminum/ S. Steel. Outer body made of mild steel is powder coated/painted. Temperature shall controlled by Microprocessor based PID Controller from 50-250C .Provided with air circulating fan. The gap between the inner & outer chamber is filled with high grade glass wool to avoid the thermal losses. Perforated adjustable trays. Two pilot lamp on/off switch. To work on 220/230 V.AC.
Size: 45x45x45cms

**Magnetic Stirrer**
With Hot Plate, Capacity: 2 liter

**Jar Testing or Multiple Spindle Stirrer**
This unit is designed for flock information fest in water treatment plants with variable speed from 25 to 150 RPM 1/20 H.P. geared motor whole unit is mounted on mild steel housing with tube lights support by four support or 9½" height. S. Steel stirring peddle 1/3" are attached to rods 10" long ¼" dia motor with lifting knob at the top. Locking collars at stirring rods permits adjustments of paddle height spacing of 6" between rods, permits use of 1000 ml beakers arresting directly on bench. Complete with ON/OFF switch.

**Mini Gas Cylinder with Regulator**

**Fume Hood**
Thick wooden board fabricated, outer is finished with Laminated Mica and inner duly painted, designed so as throw out all toxic/charmful vapors, thus protecting costly instruments and the person working in the lab. Working table top is fitted with stainless steel top, provided with SS sink and Tap. The front door moves vertically up & down with concealed counter balanced weight/by Hingers the unit is fitted with fluorescent light and a gas cock for gas/air supply. The space under the work station can be provided with switches for exhaust system and b fluorescent lights. Workable on 220 Volts AC supply.
Working Size: 4'x2'x2'.

**EQUIPMENT NEEDED FOR BACTEROLOGICAL EXAMINATION**

**Hot Air Oven**
Double walled construction .Inner chamber made of S.Steel. Outer body made of mild steel is powder coated/painted Temperature thermostatically controlled by hydraulic thermostat from 50°C to 250°C Elements are at the bottom and sides. Built in 'L' shape thermometer the gap between the inner & outer chamber is filled with high grade glass wool to avoid the thermal losses. Perforated adjustable trays. Two pilot lamp on/off switch. To work on 220/230 VAC Size: 350x350x350mm (14"x14"x14").

**Autoclave Vertical**
Outer body made of thick mild steel finished oven baked enamel Inner chamber will be thick stainless steel. The chamber is absolutely leak-proof and it can be operated at any selective point in between5 to 20 pound/Sq. inch The instrument is equipped with pressure gauge Pressure release valve, safety valve, water level indicator and perforated S.S. basket complete with cord and plug The lid is made of thick mild steel sheet duly lined with stainless steel with pedal lifting arrangements and radial locking devices to work on 220/230V AC single phase supply Inner Chamber Dia x Depth:300 x 500 mm,Load:2.0KW.

**Incubator 37°C or 44°C (Water/Air-Jacketed)**
Triple walled construction. Inner chamber made of Aluminum/ S. Steel. Outer body made of mild steel is powder coated/painted. Temperature is controlled by Microprocessor based PID Controller from Ambient + 5 to 60X.Provided with air circulating fan . The gap between the inner & outer chamber is filled with high grade glass wool to avoid the thermal losses. Perforated adjustable trays. Two pilot lamp on/off switch. To work on 220/230 V.AC.

**Binocular microscope**
Binocular Microscope : With quadruple revolving ball bearing nosepiece , low drive Co-axial mechanical stage, binocular head with hard coated prisms, graduated precise slow motion, with built in light arrangement having 6v-20w halogen lamp and solid state light control arrangement complete in box with

following optics Eye pieces WF10 x & H 5x (Three pairs) 3 pairs Objectives 4x, 10x, 40x (SL), 100x (SL) oil.

**Pipette Box (Stainless Steel)**

**Aluminum Racks 18mm, 12 holes**

**Wire Baskets Size: 140x120x110mm**

**Aluminum Foils (roll of 9 mtr.)**

**Burners with pilot lamp**

**Suction Flask (1 Litre Cap)**

**Suction Pump**

Promivac`100% Oil free Diaphragm/Piston type Vacuum-Pressure pump, portable, single/double head, complete in all respect as per following specifications.

Type : Diaphragm
Head : Double
Displacement: 45 liters. /Min
Vacuum : 27”Hg. (100 mbar)
Pressure : 55 psi
H.P. : ¼, single phase, 220-240 V
Vacuum gauge with Regulator

**Sampling Bottles**

**Measuring Cylinders (1000 Ml, 500 Ml, 200 Ml, 100 Ml, 50 Ml, 25 Ml)**

**Vacuum pump**

100% Oil free Diaphragm/Piston type Vacuum-Pressure pump, portable, single/double head, complete in all respect as per following specifications

Type : Diaphragm
Head : Double
Displacement: 45 liters. /Min
Vacuum : 27”Hg. (100 mbar)
Pressure : 55 psi
H.P. : ¼, single phase, 220-240 V
Vacuum gauge with Regulator

**Laminar Air Flow Cabinet**

Laminar air flow cabinets able to create particle free air of Class-II standard. The cabinet is fabricated out of board with sunmica laminated exterior. The working table is made of thick board which is also sunmica at top. Laminar flow is based on principle of double filtration of air. Atmospheric air will be drawn through the pre-filters by heavy duty blowers. Filtered air than passed through highly effective HEPA Filters with 99.97% efficiency for particulates of 0.3 micron or larger, which can filter almost all air born contaminants such as dust, fungal spores, bacteria etc. Double filtered laminar flow air will blow horizontally/vertically through the working table at a nominal velocity or approx 90 Fts/min. Heavy duty blowers dynamically balanced with 0.25 HP electric motor are mounted on shock resistant base of cabinet or anti-vibration pads, operate on 230 +/- 10 volts, 50 Hz AC supply. Shadow less uniform lighting is provided within working space (100 feet candles). Unit will be mounted on caster wheel and supplied with high quality plug and cord

Size: 3 x 2' x 2

**FURNITURE**

The laboratory furniture shall be modular in design, made of mainly 18 SWG CRCA/GI Sheet in panel form to get the best and full coverage of powder coating and in CKD – Completely Knocked Down construction so can be installed at site as per approved layout. Laboratory Modular Furniture includes Pedestal Frame Structure, Under Bench Storage Modules and Work Top / Surface.

The furniture shall be designed of height 900mm for standing posture and 750mm for sitting posture. Height will be maintained as per the site requirement. All metal components / parts shall be 7tanks pre-treated (with premium chemicals and DM water) and 50-60 micron Epoxy Polyester Coated with automatic robotic spray gun.

**1. WALL BENCH – 1 (20 SWG CRCA/GI sheet with PU powder coated)**

Overall Dimensions L=6000m,W=750mm,H=900mm
It consists of following.
Base Cabinet L=600mm 1 drawer 2 shutter – 10 No's
Base Cabinet L=600mm 2 shutter – 10 No's
Granite Top L=6000mm W=750mm – 1 No
PP Sink – 2 No's
Three way water tap – 2 No's
Electrical raceway - 5+10

**2. WORKING TABLE – 1 (20 SWG CRCA/GI sheet with PU powder coated)**

Overall Dimensions L=1200m,W=750mm,H=750mm
Shall consists of following.
Base Cabinet L=600mm 1 drawer 2 shutter – 1 No
**Foot rest L=600mm – 1 No**
**Granite Top L=1200mm W=750mm – 1 No**

**3. Revolving Stools**

**4. Revolving Chairs**

**5. Almirah for Storage**

**6. White-board & pens**

**Work Tables and Benches**

Minimum of 1set of work table and chair per staff shall be provided for the laboratory and office staff. The furniture and chairs shall be of ergonomic design. This work table along with the LIMS shall be isolated within a Laboratory to form a cabin with a glass partition.

The work tables shall be along the wall and shall be provided with adequate storage capacity and open glass shelves on the top to provide additional space for storage of chemicals and stock solutions.

A fume cupboard with ventilation hood shall be provided to prevent spreading of toxic and irritant fumes and odours into other parts of the laboratory. Forced ventilation with exhaust fans shall be provided. The wall space and offsets shall be convenient to locate cabinet, benches, hoods, incubators alongside without any loss of floor space.
Contractor shall also provide Almira for document storage purpose

Contractor shall also provide almirah with lock facility for document storage purpose. Separate cabinet shall be provided for storage of PPEs, Lab coats etc.

**Consumables for Laboratories**

Consumables must be replaced regularly because they wear out or are used up. Lab Consumables maybe disposable and reusable.

Contractor shall supply sufficient quantity of consumables required during testing & commissioning period as well as during entire Operation & maintenance period of contract.

The consumable includes but not limited to litmus papers, bags, Labels & markers, cleaners, bottles & caps, Gloves, Tapes, Lab containers, dishes, knives & cutters, gloves, glassware, funnels, flasks, Scalpels, Scissors & Shears, Tongs, Timers, stoppers-counters, films & foils, beakers, Pipettes, Pipettors & Tips, Crucibles, Forceps and Tweezers, white board pens, permanent markers & most importantly Reagents & chemicals, gas Cylinders etc.

**Laboratory Waste Disposal Procedures**. Waste disposal shall be managed by the appropriate party and it typically includes the following categories: municipal waste, hazardous waste, biological waste and sharps.

**Chemical Laboratory safety measures**

Personal protective equipment and safety devices must be provided to all employees under the appropriate circumstances and employees have the responsibility of properly using such equipment. According to safety regulations, it is obligatory to wear a lab coat and closed shoes in the lab, safety glasses and gloves if necessary.

Laboratories may contain certain inherent dangers and hazards Laboratories shall also be well equipped with all sort of safety measures which shall include Fire extinguishers, First Aid Box, provision for eye wash, Safety sign-boards, warning etc.

**Labels and warning signs** should alert employees to potentially hazardous materials and allow those unfamiliar with the laboratory surroundings to identify hazardous chemical use and storage areas, safety facilities, emergency equipment and exits and aid emergency response personnel.

## 13.28 Online Real Time Multi Parameters Continuous Monitoring System for Influent and Treated Sewage Parameters for the STP's

The online real time multi parameter continuous monitoring system (2 Nos shall be provided for each STP) shall be able to measure the below indicated parameters on a minimum through extractive method only for ease of operation, calibration & troubleshooting and shall have the capacity for future expansion.

On a minimum the following parameters shall be measured at the plant inlet and outlet: COD, BOD, pH, TSS,TOC, Ammonical-Nitrogen, Total Nitrogen, Dissolved Oxygen, Color & Temperature measurement at the inlet and outlet of the each STP.All of the above parameters shall be measured from one single multi parameter instrument only and shall be a same make only.

The system shall have capability to accommodate any additional parameters viz. Turbidity, Conductivity, TDS, Oil in water, etc. as may be required by the end user, from time to time.

The contractor shall provide complete analyzer with the Sample handling system. The required Pump, Sample Tubing & other necessary accessories shall be in the contractor scope of work.

The online real time multi parameter continuous monitoring system shall be equipped with inbuilt automatic cleaning facility. Required mechanism & cleaning solution for automatic cleaning shall be supplied for the entire duration of the operation and maintenance period. For the air-pressure cleaning system, Air Compressor of required capacity along with required air pipe line etc. shall be supplied.

Further, each of the STP shall be equipped with Auto samplers at the inlet and treated sewage point. Each of the online real time multi parameter continuous monitoring system shall be integrated with the Auto sampler. The online real time multi parameter continuous monitoring system is required to communicate with the auto sampler for exceedance sample so that it can store sample in Auto sampler for Lab analysis. This is to ensure that the sample taken by the auto sampler and the multi parametric analyzer are of the same time period. Contractor shall not the importance of this requirement and include the same in datasheet submission for both auto sampler and real time monitoring equipment.

All required calibration standard chemicals & reagents, are required to be provided for a complete duration of the operation and maintenance period for all mentioned parameters.

The online real time multi parameter continuous monitoring system shall accept the input signal from existing outlet Flow meter at the sewage treatment plant for display as well as Data transmission. Required cabling, any other hardware to achieve the same shall be under the contractor scope of work under this contract.

The online real time multi parameter continuous monitoring system shall be equipped with USB port for download of stored measurement data along with diagnostic files for easy troubleshooting. The minimum data storage for all the parameters shall be three months in the non-volatile memory of the equipment.

The online real time multi parameter continuous monitoring system shall be equipped with suitable communication ports for integration/ provide data to sewage treatment control system (PLC based SCADA system).

The online real time multi parameter continuous monitoring system shall have multiplexing facility to add minimum five sample streams to allow connection of additional sample stream for future requirements.

The contractor shall provide mandatory spares along with the online real time multi parameter continuous monitoring system for the entire contract which shall include:

1) 1 No of Electronic circuit Boards,
2) 1 No of Display Board,
3) Tubing's,
4) 1 No of Cleaning Pump,
5) 1 No of Spectroscopic Modules & all other required spares.

**Technical requirements:**

**A) COD (Chemical Oxygen Demand)**

| | |
|---|---|
| Measuring Principle | UV-VIS Spectroscopy with entire spectrum scanning between 180 nm to 800 nm. |
| Measuring Range | 0 –1000 mg/l(Min) |
| Accuracy | ± 2% on standard solution |
| Repeatability | ± 1 mg/l |
| Response Time | < 5 min. |

| | |
|---|---|
| Cleaning | Automatic cleaning |

**B) BOD (Biological Oxygen Demand)**

| | |
|---|---|
| Measuring Principle | UV-VIS Spectroscopy with entire spectrum scanning between 180 nm to 800 nm. |
| Measuring Range | 0 – 1000 mg/l(Min) |
| Accuracy | ± 2% on standard solution |
| Repeatability | ± 1 mg/l |
| Response Time | < 5 min. |
| Cleaning | Automatic cleaning |

**C) Ammonical Nitrogen (NH4-N)**

| | |
|---|---|
| Measuring Principle | UV Absorption after gas stripping. Measurement should be in gas phase for completely interference free measurement. |
| Measuring Range | 0 – 100 mg/l (Min) |
| Accuracy | ± 5% on standard solution |
| Repeatability | ± 0.2 mg/l |
| Response Time | < 5 min. |
| Cleaning | Automatic cleaning |

**D) Total Nitrogen**

| | |
|---|---|
| Measuring Principle | UV-VIS Spectroscopy with entire spectrum scanning between 180 nm to 800 nm. |
| Measuring Range | 0 – 100 mg/l |
| Accuracy | ± 2% on standard solution |
| Repeatability | ± 0.1 mg/l |
| Response Time | < 5 min. |
| Cleaning | Automatic cleaning |

**E) Total Suspended Solids (TSS)**

| | |
|---|---|
| Measuring Principle | UV-VIS Spectroscopy with entire spectrum scanning between 180 nm to 800 nm. |
| Measuring Range | 0 – 2000 mg/l |
| Accuracy | ± 2% on standard solution |
| Repeatability | ± 2 mg/l |
| Response Time | < 5 min. |
| Cleaning | Automatic cleaning |

**F) pH**

| | |
|---|---|
| Measuring Principle | Electrochemical Method |
| Measuring Range | 0 – 14 pH |
| Accuracy | ± 2% on standard solution |
| Repeatability | ± 0.01 pH |
| Response Time | < 1 min. |

**G) Dissolved Oxygen**

| | |
|---|---|
| Measuring Principle | Optical Method |
| Measuring Range | 0 – 20 mg/l |
| Accuracy | < 1 % of full scale |
| Resolution | < 0.01 mg/L |
| Precision | < 0.02 mg/L |
| Response time | < 1 min |
| Cleaning | Automatic cleaning |

**H) Temperature**

| | |
|---|---|
| Measuring Range | 0 – 80”C |
| Accuracy | < 0.1 C |
| Resolution | < 0.1 C |
| Precision | < 0.1 C |
| Response time | < 1 min |
| Cleaning | Automatic cleaning |

**I) Online Real Time Multi Parameters Continuous Monitoring System for Influent and Treated Sewage Parameters system**

| | |
|---|---|
| Operating Pressure | Contractor to specify |
| Operating Temperature | Sample temperature: 0 ºC to 80 ºC |
| Operating Flow | Contractor to specify |
| Enclosure protection | IP65 minimum |
| Communication | RS232 or RS485 output - USB port required for USB/ pen drive connection. |
| Memory | As specified in the technical requirements in this document |
| Display | Color LCD, with LED backlight Resistive touch screen display. |
| Measuring time/ Response time | 1 Min Programmable |
| Measuring Cycle | Continuous. |
| Power supply | 90- 264 VAC 50/60 Hz |

| | |
|---|---|
| Cleaning method | Equipment should have facility to start cleaning cycle automatically as per user defined time interval. |
| Calibration requirement | Required. Shall have auto zero calibration facility. Equipment shall have facility to start auto zero calibration as per user defined time interval.<br>Span Calibration: Shall perform as per laboratory measurement data. |
| UV Light Source | Xenon Flash Lamp |
| Expandability of measurement | Equipment shall have facility to expand measurement to meet future compliance requirements (if any).<br>Equipment shall have capability to add parameters like NO3 & Conductivity, turbidity at no extra cost.<br>Equipment shall have capability to add other parameters as mention below & should be facilitate to upgrade with Minimal cost using same enclosure.<br><br>Oil in Water: Measurement Technique by UV Fluorescence Chromium, Phosphate. Measurement Technique by Colorimetric<br><br>TDS/Conductivity: Measurement Technique by Electrochemical. |
| Additional Features | Should have Automatic Zero calibration facility which can be programmable as per user defined interval. |
| | UV source should be Xenon flash lamp with life more than 10 years. |
| | Equipment should be cabinet type (IP 65 ) for easy operation, maintenance & troubleshooting. If not the complete instrument shall be provided with IP-68 enclosure |
| | USB port for downloading stored measurement data. |
| | Should have robust flow cell which allows very high level of suspended solid without clogging and also suitable for highly corrosive water Sample. |
| | Should have automatic turbidity compensation facility by a dual wavelength |
| | USB port is required for recorded measurement download, screen copy function (easy troubleshooting) & software update |

Note: All of the above parameters shall be measured from one single multi parameter instrument only and shall be a same make only.

## 13.29 Particular Control & Automation Requirements

### A. General

This part covers the Particular requirements for the design, supply, installation, Inspection and testing of Programmable Logic Controllers (PLC) and Supervisory Control and Data Acquisition (SCADA) and associated plant and materials.

## 13.30 Design, Supply and Construction Requirements

STP PLC shall be provided as a Hot-Standby configuration to perform combinational and sequential logic functions, status monitoring and reporting functions with counter and timer facilities.

In particular, the following configuration shall be applicable across the STP.

### a) STP Main Plant PLC: Hot standby PLC

Main PLC system shall comprise of necessary hot standby PLC processors, Simplex input/output (I/O) modules(duplex I/O modules shall be provided for only critical inputs/outputs, on a minimum 25% of the total I/O's ), redundant communication interface modules, redundant power supply modules and Human-Machine Interface (HMI) required performing the desired functions.

PLC shall have the following attributes as a Hot Stand-by Controller.

- carry out sequential logic implementation for operations of plant;
- carry out computation and interfacing for data acquisition, data storage and retrieval;
- it shall accept downloaded program from a programmer;
- it shall have different functional modules to perform the desired functions;
- it shall scan the inputs in time cycles and update the status of its outputs.

The PLC system shall be expandable, OPC Compatible and shall be modular in construction, so as to be capable of future expansion without hardware modifications. PLC s shall be microprocessor based. PLC s shall use standard known protocols and structures for communication outside the system.

In case of system failure or power supply failure the outputs shall attain a predetermined fail safe condition (this shall normally be 'off').The PLC used shall have a proven record in the type of application concerned and in the prevailing environmental conditions.

All PLC based Systems should be housed in air conditioned environment. The contractor shall submit the sizing calculations for the air conditioning system for review and approval.

The contractor shall refer the approved vendor list for the PLC system and hardware, elsewhere in this document.

### b) Remote input/output modules (RIO)/Panels

The PLC system shall consist of field remote input/output modules (RIO) and panels. Each RIO panel shall consist of redundant communication modules, power supply modules, minimum 15" color panel mounted HMI with touch screen functionality. It shall be possible to view and acknowledge the alarms and view set points for the particular process from the HMI etc.

**c) I/O Modules:**

Standard rack mounted plug in I/O modules shall be provided. I/O Modules should be of the same series as the PLC CPU. Refer the approved vendor list for the PLC system and hardware, elsewhere in this document.

Field wiring shall be terminated in screwed terminal blocks and interconnected to the processor I/O system with prefabricated cables and plug in card type connectors. I/O Modules should be hot swappable.30% extra modules of installed capacity for each type of module shall be provided as spare. In addition to the above, provision shall be made for future expansion of additional 30% extra I/O modules of the installed capacity in the panel. The panel drawings shall reflect the same.

I/O modules shall be as follows:

a) inputs shall be opto isolated.;
b) filters shall be provided for noise rejection;
c) output status shall be indicated by an LED;
d) all outputs shall be fuse protected and have fuse failure indication the fuses may be mounted externally from the output module;
e) all the modules shall be of addressable type.
f) Ethernet I/O modules shall be connected to the PLC by on board Ethernet 10/100 Base T connection port. Ethernet I/O modules shall support multiple communications including TCP/IP and Modbus ASCII and RTU allowing connection to any device supporting these protocols over standard Ethernet backplane.

Each PLC shall have memory protected built in historical archiving/data logging of system alarms & events and process variables. Data logger shall be able to log data based on time or an event. PLC shall have enough memory allocated to allow 200,000 time and data stamped discrete and /or analog values to be archived. The historical archive shall allow the oldest data to roll off the system as memory is used keeping the 200,000 most current data points available. Process point time stamping frequency shall be selectable within the configuration software. It shall be possible for the archived data to be exported in CSV format allowing use with standard spreadsheet and data software applications

The PLC system shall be expandable, OPC Compatible (OPC should be a built in feature of the software and hardware. No external software patch or hardware module is allowed) and shall be modular in construction, so as to be capable of future expansion without hardware modifications.

**d) Dual Redundant Processors (CPU)**

The master station shall be provided with two identical central processors configured such that they operate in Hot-Standby mode.

Redundant system with hot back up redundancy feature should be built in the CPU. Software engineered hot backup systems are not acceptable. CPU should have the memory expansion capability up to 7 MB.

SCADA connectivity with the CPU will be on dual Ethernet network (10/100 Mbps with open Modbus TCP/IP protocol). On the event of hardware failure in primary system the standby system will provide dual connectivity with the SCADA.

Redundancy of switch for SCADA (industrial grade managed switch) connectivity is to be provided. PLC CPU and I/O modules shall be of the same logic family.

The system shall be designed and implemented such that when the Main processor fails, the Standby one shall automatically take over. The changeover shall be seamless, smooth and without any time delay and shall not cause any disruption to the overall distributed control system and to the ongoing processes.

The PLC system shall be expandable (OPC Compatible) and shall be modular in construction, so as to capable of future expansion without hardware modifications.

The system hardware, application software and database shall be sized to accommodate a total of 50% increase in signal capacity and up to 100% increase in an individual zone.

PLC s shall be microprocessor based. PLC s shall use standard known protocols and structures for communication outside the system. In case of system failure or power supply failure the outputs shall attain a predetermined fail safe condition (this shall normally be 'off').The PLC used shall have a proven record in the type of application concerned and in the prevailing environmental conditions.

Application logic programs shall be fully compliant with all five logic development methods detailed in IEC 61131-3. The PLC shall be powered by two independent sources provided by the UPS system and all internal operating supplies shall be derived from the UPS.

The power supplies, I/O modules, CPU and communication modules shall be monitored by the PLC and shall be available by report. The same shall be monitored on the SCADA screen.

During the times of the battery discharge, the PLC shall initiate an orderly self-shutdown and automatically restart on the main power restoration without the need for reloading or initiation of any kind. The PLC shall comply with the specification specified elsewhere in this specification.

**e) Central Processing Units**

The central processing units (CPU) shall be a high performance processor with modular configuration suitable for real time process applications. The following additional features shall be provided:

Redundant system with hot back up redundancy feature should be built in the CPU. Software engineered hot backup system will not be not acceptable. CPU should have the memory expansion capability of minimum 7 MB.

SCADA connectivity with the CPU will be on dual Ethernet network (10/100 Mbps with open Modbus TCP/IP protocol). On the event of hardware failure in primary system the standby system will provide dual connectivity with the SCADA.

Redundancy of switch for SCADA (industrial grade managed switch) connectivity should be provided. Communication between CPU and peripherals shall be by an I/O bus. The individual device, interfaces shall be capable of being plugged into the I/O bus. On resumption of power following a power failure the PLC shall automatically restart its controlling function.

CPU shall have a real time clock capability to accept a time synchronization pulse and adjust its internal clock with the pulse. CPU shall have extensive self-diagnostic facilities and watch dog timers to identify faults at card levels

**f) Memory Unit**

Memory unit shall comprise of highly reliable memory chips which are industry standard, proven design with fast random access and suitable for operation in process environments. Main memory shall be modular and facility shall be provided for the upgrading and expansion of memory to meet future demands.

Not less than 50 % spare program memory and data memory space shall be provided. System initialization and application software shall be stored in EEPROM or EPROM. Operating data shall be stored in a RAM fitted with an internal battery backup.

**g) I/O Modules**

Standard rack mounted plug in I/O modules shall be provided. I/O Modules should be of the same series as the PLC CPU. Field wiring shall be terminated in screwed terminal blocks and interconnected to the processor I/O system with prefabricated cables and plug in card type connectors.

30% extra modules of installed capacity for each type of module shall be provided as spare.

I/O modules shall be as follows:

- inputs shall be opto isolated.;
- filters shall be provided for noise rejection;
- output status shall be indicated by an LED;
- all outputs shall be fuse protected and have fuse failure indication the fuses may be mounted externally from the output module;
- all the modules shall be of addressable type.
- Ethernet I/O modules shall be connected to the PLC by on board Ethernet 10/100 BaseT connection port. Ethernet I/O modules shall support multiple communications including TCP/IP and Modbus ASCII and RTU allowing connection to any device supporting these protocols over standard Ethernet backplane.

**h) Analogue Input Modules**

They shall consist of an input isolation unit, signal conditioning unit and an analogue to digital converter (ADC). In addition, the following features shall be provided.

- cross talk attenuation
- provision for monitoring of the ADC for overflow detection
- gain amplifier with high common mode rejection ratio
- accuracy for analogue signals shall be 0.5%

**i) Digital Input Modules**

The following design features shall be provided.

- contact bounce protection;
- choice of type of contacts.

**j) Digital Output Modules**

The digital output module shall provide contact closure output by driving relays. The features to be provided are as follows:

- contact bounce protection shall be provided
- relay output shall be provided to operate pump motors and motorised valve actuators
- fail safe position in case of output module failure and fault indication

PLC's provided under this specification shall be capable of performing the necessary logic to control the system as previously defined. These capabilities shall include, but not be limited to the following:

| | |
|---|---|
| 1) Discrete input/output | 10) Latch/unlatch relays |
| 2) Analog input | 11) Counters |
| 3) Analog output | 12) Comparators |
| 4) Timers | 13) Ladder logic |
| 5) Pump Controller | 14) Flow Totalization/ Integration |
| 6) Pump Alternation | 15) Intrusion Detection |
| 7) Mathematical Function Blocks | 16) Time of Day Control w/Lockout |
| 8) Stage Blocks | 17) Ramp Blocks |
| 9) Trending | 18) Data Logging |

**A. PLC Programming**

PLC programming shall be carried using **functional block diagrams (FBD) only**. The logic shall be prepared using proprietary programming software and shall be comprehensively annotated with subroutine and rung comments to assist further development and maintenance.

The system shall support a simple programming of the application software comply with IEC 61131-3.

The system shall support a structured, modular programming. At least the following standard operations shall be applicable:
1) Logic functions (such as AND/OR/AND NOT etc.);
2) Timer functions (externally adjustable);
3) Counter functions;
4) Skip functions;
5) Comparison functions;
6) Limit value functions;
7) Arithmetic functions;
8) Physical unit functions;
9) Closed-loop functions such as P/PI/PID/etc.

The Contractor shall submit the logic diagrams for review. The Contractor shall include the as-built logic in the final submission.

**B. Programming Unit**

The programming unit –Industrial grade laptop (16" screen) shall be of the portable type, designed to be used during commissioning on site. A functional keyboard which supports different type of programming methods shall be included, as well as a LCD display.

On a minimum, the following functions shall be included:
i) On-line programming

ii) Off-line programming
iii) Flexible corrections during input
iv) Full screen editing functions
v) Absolute and symbolic programming
vi) Input of comments and title blocks for complete documentation
vii) Complete application software documentation functions. Printouts of application
viii) Software logic functions shall preferably be in Ladder logic diagrams.
ix) Load and transfer functions

The portable programming unit with minimum 16" screen shall be provided complete with proprietary PLC programming and SCADA software complete with plant mimics and documentation software. Necessary license for SCADA shall also be supplied and loaded on to the system. Communications cables required to interact with the PLC, (E.g.: Modbus Cable) would be supplied by the contractor.

The software shall provide facilities for:

- carrying out program revision management;
- insertion of comprehensive program subroutine and rung comments;
- search and find and search and replace 'contacts' and 'coils';
- simulation functions and testing of the program by changing the status of contacts and monitoring the outputs;
- preparation of coil and contact list and their locations and memory maps;
- make system backup copies while the system is online;
- upload and down load programs to the PLC on line;
- Carry out on line maintenance and fault finding on the PLC.

**C. HMI**

The HMI shall be with 15" color screen and with touch screen capabilities with IP-65 rating.

All Remote I/O panels which are connected to the main plant PLC based SCADA system shall be equipped with a 15"minimum, panel HMI .The HMI graphic shall be suitable for day to day operation by non-computer literate personnel in the monitoring and operation of the treatment works.

The HMI shall provide efficient and safe operation of the process plant by detecting alarm and error conditions, alerting the operator to these conditions both visually and audibly, monitoring all important system parameters and providing facilities for plant optimization. The system will allow operators, technicians and Employer Representatives to issue commands to change system parameters, start and stop equipment, provide configuration tools and operate diagnostic facilities.

The System shall perform all the necessary functions for the optimum monitoring, control and operation of the particular system. HMI unit along with software packages shall be considered, and also those software packages and Hardware shall be compatible with TCP / IP protocols as well as OPC communication (Open Standard Communication).

The Human Machine Interface (HMI) shall offer a high resolution and high brightness touch screen and include support for processors for up to 1GHz pulse wave,. The HMI shall be rugged and CE-certified and shall offer protection from vibration and changing ambient temperatures, shall include Built-in stereo speakers to increase utility and provide operational flexibility to the plant operators. The HMI shall include high-resolution displays (up to 1920x1080) to ensure clear data visualization, along with dual Ethernet ports and multiple serial interfaces for flexible connectivity. The HMI shall be designed to run well on any x86 Windows platform.

HMI shall offer multiple options for Ethernet and serial interfaces for flexible connectivity. Additionally, HMI Runtime license shall be included at no extra cost .The HMI shall fully support Industry 4.0 technology. The HMI shall support MQTT protocol for secure data transfer, OPC UA for standardized data exchange, and integrate for advanced analytics. HMI Security shall be with multi-layered protection, including file encryption, detailed user access control; audit trails, and secure remote access.

**D. Ethernet Switches**

The contractor shall only provide managed industrial grade managed Ethernet switches under this contract. All switches shall be in redundant configuration.

## 13.31 Minimum I/O Requirements for Auto mode Control operation of the Plant:

On a minimum, the control design shall incorporate the I/O requirements which are indicated in the table. All process & Instrumentation Diagrams (P&ID) shall incorporate & depict the minimum I/O requirements as indicated in the table below.

Design shall include complete auto mode of operation of the entire STP and associated plants/stations with all necessary interlocks and safety mechanisms.

Minimum I/O to be provided under this contract for the Control system and to be included in the system design is as under:

| Sl No | TYPE | MINIMUM I/O'S TO BE CONSIDERED AND INCLUDED |
|---|---|---|
| 1. | Pump, Motor | Start, Stop, Available, Auto, Off, Manual, Run, Emergency Stop, Fault, Speed ref |
| 2. | Valve | Available, ,Auto, Off, Manual, Open, Close, Travelling Indication, Fault |
| 3. | Drives | Available, ,Start, Stop, Auto, Off, Manual, Run, Emergency Stop, Fault |
| 4. | Blower | Available, , Start, Stop, Auto, Off, Manual, Run, Emergency Stop, Fault |
| 5. | Level Indicator | HH, H, L, LL, Analog value, |
| 6. | Level Switch | HH, H, L, LL, |
| 7. | Analytical Instruments | Analog Value, |
| 8. | Pressure Indicator transmitters | Shall be provided at **(**in addition to all individual pumps, blowers**,** at common discharge end of pumps, blowers, dosing pumps etc...): Analog Value, |
| 9. | Flow Indicator Transmitters | Shall be provided at **(**in addition to other plant flows**,** at common discharge end of pumps, blowers, dosing pumps etc...): Analog value, totalizer, |

## 13.32 Typical Drive Control Philosophy to be provided on a minimum shall be as follows:

| SL. NO. | DESCRIPTION | Type of I/O | No of I/O |
|---|---|---|---|
| **1.** | **PLC INTERFACE FOR UNIDIRECTIONAL HT DRIVE / LT BREAKER CONTROL DRIVE (Signal Exchange has been envisaged between PLC and switchgear)** | | |
| a. | Start Command | DO | 1 |

| SL. NO. | DESCRIPTION | Type of I/O | No of I/O |
|---|---|---|---|
| b. | Stop Command | DO | 1 |
| c. | ON Feedback | DI | 1 |
| d. | OFF Feedback | DI | 1 |
| | Auto, Off, Manual | DI | 3 |
| e. | Swgr. Disturbance (Overload relay operated/ control supply fail/ | DI | 1 |
| | Emergency LPBS stop) | DI | 1 |
| | Available | DI | 1 |
| f. | Electrical Trip (Motor Protection Relay) | DI | 1 |
| g. | Switchgear Available (breaker in service position, switchgear in remote & breaker spring charged) | DI | 1 |
| h. | Pump bearing temperature measurement | AI | 2 |
| i. | Motor Bearing temperature measurement | AI | 2 |
| j. | Motor Winding temperature measurement | AI | 6 |
| k. | Current Transducer input | AI | 1 |
| **2.** | **PLC INTERFACE FOR UNIDIRECTIONAL LT DRIVE (Signal Exchange has been envisaged between PLC and PCC/MCC)** | | |
| a. | Start Command | DO | 1 |
| b. | Stop Command | DO | 1 |
| c. | ON Feedback | DI | 1 |
| d. | OFF Feedback | DI | 1 |
| | Auto, Off, Manual | DI | 3 |
| | Available | DI | 1 |
| e. | Swgr/MCC Disturbance (Overload relay operated/ control supply fail/ | DI | 1 |
| | Emergency LPBS stop) | DI | 1 |
| f. | Switchgear/MCC Available (switchgear/MCC in remote) | DI | 1 |
| **3.** | **PLC INTERFACE FOR BIDIRECTIONAL LT DRIVE- For Integral starters (Signal Exchange has been envisaged between Actuator and PLC.)** | | |
| a. | Open Command | DO | 1 |
| b. | Close Command | DO | 1 |
| c. | Integral starters Fault | DI | 1 |
| d. | Open limit switch feedback | DI | 1 |
| e. | Close limit switch feedback | DI | 1 |
| | Auto, Off, Manual | DI | 3 |
| | Available | DI | 1 |
| f. | Position Transmitter (For inching type Drive) | AI | 1 |
| g. | Command | AO | 1 |
| **4.** | **PLC INTERFACE FOR BIDIRECTIONAL LT DRIVE-For Non-Integral starters (Signal Exchange has been envisaged between Actuator and PLC.)** | | |
| a. | Open Command | DO | 1 |
| b. | Close Command | DO | 1 |
| | Auto, Off, Manual | DI | 3 |
| c. | Swgr/MCC Disturbance (Overload relay operated/ control supply fail/ | DI | 1 |

| SL. NO. | DESCRIPTION | Type of I/O | No of I/O |
|---|---|---|---|
| | Emergency LPBS stop) | DI | 1 |
| | Available | DI | 1 |
| d. | Switchgear/MCC Available (switchgear/MCC in remote) | DI | 1 |
| e. | Open limit switch feedback | DI | 1 |
| f. | Close limit switch feedback | DI | 1 |
| g. | Position Transmitter (For inching type Drive) | AI | 1 |
| **5.** | **PLC INTERFACE FOR SOLENOID DRIVE (Single coil)** | | |
| a. | Energise or Deenergise | DO | 1 |
| b. | Open limit switch feedback | DI | 1 |
| c. | Close limit switch feedback | DI | 1 |
| **6.** | **PLC INTERFACE FOR SOLENOID DRIVE (Double coil)** | | |
| a. | Energise | DO | 1 |
| b. | Deenergise | DO | 1 |
| c. | Open limit switch feedback | DI | 1 |
| d. | Close limit switch feedback | DI | 1 |
| **7.** | **PLC INTERFACE FOR PNEUMATIC DRIVE** | | |
| a. | Command to I/P converter | AO | 1 |
| b. | Position Transmitter | AI | 1 |
| c. | Open limit switch feedback | DI | 1 |
| d. | Close limit switch feedback | DI | 1 |
| e. | Command to Solenoid valve (Wherever applicable) | DO | 1 |

## 13.33 Closed Circuit Television (CCTV) System

Design, supply, install, test and commission CCTV system including its interface with main plant SCADA system; The contractor shall install the CCTV cameras at all process locations(both indoor & outdoor).During construction ,the CCTV system shall be installed at all process locations/construction points and the CCTV feed shall be used to monitor the project progress in real time through the standard web browsers of the system provider.Contractor shall ensure that the CCTV feed is web based and can be accessed through standard web browsers. High speed broadband internet connection shall be utilized on site to relay the CCTV feeds as required for monitoring remotely.Provision of high speed broadband internet connection of minimum 200 MPBS shall be under the scope of the contractor.

The contractor shall be responsible for the detailed design, supply, installation, testing and commissioning and training of Employer's staff of Closed Circuit Television (CCTV) system to be installed in the SCADA control room & at all process locations in the plant on a minimum covering all process units ,entrance to the STP and TSPS, along the boundary wall, storage facilities and other areas of the STP and TSPS. The CCTV system shall be designed to have complete coverage of the plant.

The scope shall include all necessary cabling, indoor & outdoor cameras and lenses, camera housing, CCTV monitor(32" LED SCREEN ), control and interface units, coaxial cable transmission, video switching unit, time-lapse video recorders and tapes, junction boxes, power supplies, mounting brackets, etc, as required to provide a cost effective and reliable and fully operational CCTV system complying with the specification and to the approval of the Employer's Representative.

The CCTV system shall incorporate all equipment necessary to enable all areas to be viewed from the CCTV station monitor. The CCTV monitoring system shall be of latest design incorporating all the power

and signal wiring as per manufacturer's standard. The system shall be complete package of one supplier of equipment, fixings, wiring conducting and all items necessary for a complete installation.

**Materials**

**Cameras**

Cameras shall be digital high resolution colour cameras having 1/3 inch CCD 450 TV lines with lens and an interlace of 2:1 in the scanning system of high excellent quality and performance utilising latest digital technology of super colour reproduction with low light high sensitivity down to 5 lux with electronic shutter speeds 1/50 to 1/30000 seconds .

Cameras shall be provided with a 14mm automatic lens with/without "drive" (amplifier) for 1/2" sensors, F1.4 CS mount, 22° angle shot and a composite video output at 75 ohms lines and the useful illumination range shall be 1.5 lux.The camera lens shall be of the auto iris zoom type with spot filter providing automatic control throughout the iris range from fully open F1.4, the lens shall incorporate a shutdown mechanism to protect the camera from high light level during periods of not in use. A neutral density filter designed to maintain image detail and contrast shall be incorporated in the lens. The output signal shall be of PAL. The Camera shall be suitable for the specified environmental conditions.

The camera shall be provided complete with all accessories required. The camera shall have the following features.

1. Program modes 1.5, 3, 6 minutes;
2. Variable scan speed between 1.40° per second;
3. Programmable limit stops for auto/random/frame scan modes;
4. Series protocols BS-422 'P' series and 'D' series;
5. Built-in menu system;
6. Pan movement – 360° continuous pan rotation;
7. Vertical tilt - Unobstructed +2 to +92°;
8. Variable pan/tilt speed controller;
9. Preset speeds:
Pan – 250°/sec
Tilt – 100°/sec
10. Electrical input – 24V AC.

**Monitor**

The monitor shall be of high resolution type suitable for CCTV system and shall comply with the following:

1. LED Screen: 32";
2. Power Supply: 240V, 50Hz;
3. Resolution : 420 lines;
4. Bandwidth : 5 MHz (±3dB);
5. Video Input : 1 Vpp 75ohm;
6. Input/Output: BNC Video connector;
7. Front Controls: Power ON/OFF;
8. Brightness Control;
9. Contrast Control;
10. Colour Control.

**Matrix Switcher**

The matrix switcher shall be micro-processor based and provide switching and control for 16 video inputs and up to 4 monitor outputs from any one keyboard. The unit shall be remotely operated by desk-top key boards or external computer systems. The switcher shall have on-screen menu programming. The switcher shall support two system macros or salvo sequences to allow quick call-up of up to four cameras to four monitors simultaneously.

The salient features of the switcher shall be as follows:

1. 16 volts inputs; 2 or 4 video outputs;
2. 20-character camera title;
3. Time (24-hour or AM/PM formats), Date (4 formats);
4. Video inputs individually detectable for terminating or looping;
5. Individual monitor sequential switching with preset cell;
6. Compatible with RS 422 protocol;
7. Camera control selection;
8. Full duplex RS485 keyboard communications;
9. Selectable data port – RS 232/RS 422/RS 425;
10. Password protected menu programming;
11. User partitioning to prevent un authorised viewing.

**Receiver**

The receiver shall operate on the principle of transmitting of transferring control information and video data on the same line. Standard control features shall include pan/tilt control, camera power, zoom lens control (zoom, iris, and focus with adjustable speed).The receiver shall be compatible with control systems utilizing standard 15-bit command protocols. Auto random scan capability or preset positioning shall be possible.

The test local control module shall allow on-site testing of system functions.

The salient features of the receiver shall be as follows:

1. Input power – 240V 50Hz AC;
2. Control method – 15 pulse train superimposed on the video signal;
3. Pulse amplitude – approximately 1 Vp-p added to video signal, 333kHz nominal;
4. Connectors – two BNC connector for video input and output one 37pin
   Amp CPC for control output;
5. Input video level – 1 Vp-p nominal, 2 Vp-p maximum;
6. System band width – Less that 2dB down at 10 MHz;
7. Fuse protection – 3 AG type;
8. Power chord – 3 wire grounded 18 AWG;
9. Operating distance – RG 11 at 1828 m;
10. Ambient temperature –20 to + 60°C.

The receiver shall be UL listed and shall comply with NEMA 4X and be CE compliant.

**Amplifier**

The video amplifier shall be of solid state circuitry and is meant for post equalization application only. The amplifier shall provide effective means of maintaining CCTV picture quality with RG11 coaxial cable.

The general construction of the amplifier shall consist of cover, chassis and panel.

The salient features of amplifier shall be as follows:

1. Input voltage – 240V AC;
2. Power transformer – 1.5VA (1.25 AMP) at 12 ±15% volts, 50Hz;
3. Input – Single BNC internally terminate in 75ohms;
4. Outputs – Single BNC source terminated;

5. Gain – Adjustable form 1 to 8dB;
6. Frequency response – Adjustable form flat (±1dB) at 12 MHz, greater than 18dB of boost at 12 MHz;
7. Output dynamic range – Up to 2 volts p-p at 50% APL;
   Up to 1.5 volts p-p at 90% APL.
8. Cable length – RG 11 – 1828.8M;
9. Ambient temperature – 0° to 48.89°C at 0 - 90% RH.

The amplifier shall be UL listed to standard 2044 and comply with NEMA 1 and be CE compliant.

**Time Lapse Video Cassette Recorder or Disk recorder**

The time-lapse VCR/disk recorder shall be designed to suit multiple use. The recording capability shall enable continuous coverage over a long period of time with minimum tape changes.

Recording mode shall include standard VHS2 and 6-hour real time modes in addition to high density 18-hour linear real time recording. SP and EP recording modes shall make increase field recoding rate using standard high quality T120 VHS tapes.

The programming menu shall appear on the monitor output to provide easy setup of any programme feature. A lock mode shall disable all front panel controls presenting all changes to the unit's programming or operation. Playback features shall include speed search and reverse play back. Automatic alarm search feature shall allow the operator to go to a specific alarm index.

The salient features of disk recorder shall be as follows:

1. Standard VHS 2/6 hour recording mode;
2. 18/24/218/72/96/120/168 hour VHS compatible time-lapse modes;
3. Internal / short recording mode;
4. 24 hours real time recording mode;
5. High density record mode – triple speed time lapse recording;
6. Audio recording up to 24 hours;
7. Alarm index search;
8. Jog/shuttle for easy forward and reverse field playback and search;
9. On-screen menu programming;
10. Eight daily/weekly reading schedules.

**CCTV Integration**

A Close Circuit Television Camera's (CCTV) based on IP standard should be amenable to be integrated with the SCADA system. The camera integration feature should be a standard feature of SCADA in following ways -

Web Services
Video Viewer - ActiveX Control
PTZ Control (Pan, Tilt, Zoom) - ActiveX Control
Camera Manager
Add / Edit / Remove cameras in runtime environment
Camera configuration stored in DBF files
Pre-built Displays:

1 Up
2 Up
4 Up
9 Up

Additional features such as pop-up displays for motion/intrusion detection and linking of events with video functions should be made available.

Broadband internet services with high speed connectivity shall be used for data communication from CCTV monitoring locations to the CCTV server. The most suitable package of high speed broadband internet service provided by an Internet Service Provider (ISP) which suits the Client's requirement for high speed real time monitoring thru the CCTV shall be utilized. The contractor shall enter in to SLA agreement to provide continuous fail safe services as required under this contract.

## 13.34 Approved Vendor/Manufacturer/Make List-CCTV

The naming of a manufacturer in this specification is not intended to eliminate competition or prohibit qualified manufacturers from offering equipment. Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired.

| **Description** | **Vendor/Manufacturer/Make** |
|---|---|
| CCTV systems | 1. M/S SONY<br>2. M/s HITACHI<br>3. M/S HONEYWELL<br>4. M/s BOSCH<br>5. M/s HIK VISION |

## 13.35 Approved Vendor/Manufacturer/Make List-Instrumentation

The naming of a manufacturer in this specification is not intended to eliminate competition or prohibit qualified manufacturers from offering equipment. Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired.

**i) List of Makes for Instruments:**

| **Sr. No.** | **Description** | **Vendor/Manufacturer/Make** |
|---|---|---|
| 1 | LEVEL INDICATOR TRANSMITTER | M/S ABB-GERMANY<br>M/S ENDRESS+HAUSER<br>M/S SIEMENS<br>M/S EMERSON |
| 2 | FLOW METERS/FLOW INDICATOR/ TRANSMITTER (ELECTROMAGNETIC, THERMAL, ULTRASONIC) | M/S EMERSON-USA<br>M/S ENDRESS+HAUSER<br>M/S SEIMENS-GERMANY<br>M/S ABB-GERMANY<br>M/S FORBES MARSHALL |
| 3 | LEVEL/FLOAT SWITCHES | M/S ABB-GERMANY<br>M/S ENDRESS+HAUSER,<br>M/S KROHNE GMBH GERMANY<br>M/S P&F GERMANY<br>M/S LEVCON,<br>M/S. PUNE TECHTROL |
| 4 | PRESSURE GAUGES | M/S GENERAL INSTRUMENTS<br>M/S. BAUMER<br>M/S ASAHI<br>M/S WIKA |

| Sr. No. | Description | Vendor/Manufacturer/Make |
|---|---|---|
| 5 | PRESSURE INDICATOR TRANSMITTER & SWITCHES | M/S EMERSON-USA<br>M/S ENDRESS+HAUSER<br>M/S SIEMENS<br>M/S ABB-GERMANY |
| 6 | ONLINE RESIDUAL CHLORINE ANALYZER | M/S ENDRESS+HAUSER<br>M/S DKK -JAPAN<br>M/S PROCESS INSTRUMENTS –UK<br>M.s SUNSHINE ANALYTICA |
| 7 | TEMPERATURE INDICATOR TRANSMITTERS | M/S ENDRESS+HAUSER<br>M/S YOKOGAWA (JAPAN)<br>M/S ABB-GERMANY<br>M/S SIEMENS<br>M/S FUJI ELECTRIC |
| 8 | ANALYTICAL ONLINE INSTRUMENTS (DO, ORP, pH, TURBIDITY,SLUDGE BLANKET MONITOR) | M/S IN SITU(USA),<br>M/S ENDRESS+HAUSER<br>M/S PROCESS INSTRUMENTS- U.K<br>M/S DKK (JAPAN)<br>M/S XYLEM |
| 9 | ONLINE REAL TIME INFLUENT & EFFLUENT MONITORING SYSTEM | M/S HORIBA-(FRANCE)<br>M/S DKK (JAPAN)<br>M/S IN SITU-(USA)<br>M/S AQUALABO-FRANCE |
| 9 | ALL WEATHER REFRIGERATED AUTO SAMPLERS | M/S CAMPBELL SCIENTIFIC –USA<br>M/S WATERSAM-GERMANY<br>M/S SUNSHINE ANALYTICA |
| 11 | LABORATORY EQUIPMENT | M/S MACHERY –NAGEL<br>M/S DKK (JAPAN)<br>M/S YAMOTO SCIENTIFIC CO.LTD (JAPAN)<br>M/S IDEXX<br>M/S-SUNSHINE<br>M/S SHIMADZU (JAPAN)<br>M/S SAVANT<br>M/S. MN |
| 12 | LABORATORY INFORMATION MANAGEMENT SYSTEM | M/s LABWARE<br>M/S LABOQUANT<br>M/S AQUADAMIX |
| 13 | UN-INTERRUPTIBLE POWER SUPPLY SYSTEMS | M/S FUJI ELECTRIC<br>M/S HITACHI<br>M/s DELTA<br>M/S AVO |
| 14 | BATTERIES | M/S AMCO<br>M/S EXIDE<br>M/S SEC<br>M/S AMAR RAJA |

| Sr. No. | Description | Vendor/Manufacturer/Make |
|---|---|---|
| 15 | PANELS | M/S RITTAL<br>M/S ELDON<br>M/S HOFFMAN |
| 16 | CABLES | M/S UNIVERSAL CABLES<br>M/S HAVELL'S<br>M/S CCI<br>M/S FINOLEX<br>M/S NICCO<br>M/S DELTON CABLES LIMITED |

Note-1: In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service, like items of equipment provided hereunder shall be the end products of one (1) manufacturer.
Note-2: All products shall be completely manufactured in the country of Origin as indicated. Assembled products shall not be accepted.
Note-3: In the event that the contractor wishes to propose alternate makes for the equipment mentioned above, he shall submit the following during detailed engineering:
1) Demonstrate that the proposed makes are "equivalent " to the approved makes. The contractor shall ensure that alternate makes proposed, shall comply completely to the tender specifications, before the same is submitted for approval.
2) Submit ISO certificates for the OEM.
3) Submit quality certificates that the equipment adheres to, as required under this contract.
4) Submit product brochures for the proposed equipment.
5) Manufacturer involved in manufacture of specified equipment for at least 10 years before bid date
6) End user performance certificates for minimum 10 successful individual installations of ***similar size and application*** as per this contract with the proposed equipment and model no, commissioned in last 5 years before bid date and satisfactorily operating for at least three years before bid date. Contractor to submit end user reference certificates for each of the installations referenced.
7) Manufacturer to provide full contact information for each reference as part of technical bid.

## 13.36 Approved Vendor/Manufacturer/Make List-Automation

The naming of a manufacturer in this specification is not intended to eliminate competition or prohibit qualified manufacturers from offering equipment. Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired.

| Sr. No. | Description | Manufactures/Makes | | |
|---|---|---|---|---|
| 1 | WORKSTATIONS, SERVERS, LAPTOP NOTEBOOK | M/S-DELL<br>M/S-HP<br>M/S-TOSHIBA | | |
| 2 | PROGRAMMABLE LOGIC CONTROLLERS & IO MODULES | **Make** | **CPU Series** | **IO Series** |
| | | SCHNEIDER ELECTRIC | MODICON M580 | MODICON M580 SERIES |
| | | SIEMENS | S7-1500 H | S7-1500 H |
| | | ALLEN BRADLEY | CONTROL LOGIX 1756 SERIES | CONTROL LOGIX 1756 SERIES |

| | | | | |
|---|---|---|---|---|
| | | MITSUBISHI ELECTRIC | IQR SERIES PROCESS CPU | IQR SERIES |
| | | OMRON | CS1D-CPU 6X SERIES | CS1D SERIES |
| | | PHOENIX CONTACT | RFC 4072R | RFC-AXIOLINE SERIES |
| 3 | SCADA PROGRAMMING SOFTWARE | WIN CC, FT VIEW, AVEVA SYSTEM PLATFORM, ICONICS-GENESIS64, CX-SUPERVISOR, VISU+ SCADA<br>Note: All software's shall be of the latest series version and shall include both runtime and developer versions. | | |
| 4 | HISTORIAN SOFTWARE | AVEVA HISTORIAN<br>ICONICS-HYPER HISTORIAN<br>SIMATIC PROCESS HISTORIAN<br>FACTORY TALK HISTORIAN SE<br>PROGEA- MOVICON<br>PHOENIX – HISTORIAN | | |
| 5 | DC POWER SUPPLY | M/S-APLAB, M/S-WAGO, M/S-PHOENIX CONTACT, M/S-MEAN WELL, M/S-WEIDMULLER, M/S-OMRON. M/S-SHAVISION | | |
| 6 | TOUCH SCREEN COLOR PANEL HMI | M/S-ADVANTECH HMI NAVI, M/S-MITSUBISHI-GOT 2000 SERIES, M/S-SIMATIC WINCC UNIFIED, M/S SCHENEIDER-HARMONY GTU | | |
| 7 | LED MONITORS/DISPLAYS/VDU | M/S-SAMSUNG, M/S-LG, M/S-DELL,M/S-HP | | |
| 9 | ALL IN ONE PRINTERS | M/S- CANON, M/S-EPSON, M/S-XEROX | | |

Note-1: In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service, like items of equipment provided hereunder shall be the end products of one (1) manufacturer.

Note-2: All products shall be completely manufactured in the country of Origin as indicated. Assembled products shall not be accepted.

Note-3: In the event that the contractor wishes to propose alternate makes for the equipment mentioned above, he shall submit the following during detailed engineering:

1) Demonstrate that the proposed makes are "equivalent " to the approved makes or superior. The contractor shall ensure that alternate makes proposed, shall comply completely to the tender specifications, before the same is submitted for approval.
2) Submit ISO certificates for the OEM.
3) Submit quality certificates that the equipment adheres to, as required under this contract.
4) Submit product brochures for the proposed equipment.
5) Manufacturer involved in manufacture of specified equipment for at least 10 years before bid date
6) End user performance certificates for minimum 10 successful individual installations of *similar size and similar application* as per this contract with the proposed equipment and model no, commissioned in last 5 years before bid date and satisfactorily operating for at least five years before bid date.

7) Manufacturer to provide full contact information for each reference as part of technical bid.

## 13.37 Supervisory Control and Data Acquisition System (SCADA)

The SCADA shall be a fully integrated microprocessor based control and data acquisition system which will monitor, control, display, record, archive plant and historical data and trend all assigned plant inputs and outputs. The SCADA shall be a fully dual redundant microprocessor based computer system such that reliable and fully automatic plant control can be achieved.

SCADA system would be dual redundant server system. The system shall be designed and implemented such that the failure of a central processor or HMI console does not inhibit continuous automatic control of the plant.

Failure of a single outstation or communications to that outstation shall not effect control or operation of any other outstation, unless the failed outstation provides essential data to another outstation, in which case the non-failed outstations shall revert to a fail-safe mode.

An alarm shall be generated whenever a communications system failure occurs.

The SCADA system shall provide a complete monitoring & control of the entire STP and TSPS facility via the redundant PLC based control system and RIO system.

STP SCADA system shall comprise the following on a minimum:

a) Dual redundant SCADA servers with SCADA server software, server grade machines with RAM as specified elsewhere and web servers ( tags shall be 25% PLUS the configured tags)
b) Historian server system inclusive of the historian software to match the tag database of the SCADA software PLUS 50% of tags.
c) Engineering & Operator work stations )14$^{th}$ generation Intel core i7 processor and above,32 GB RAM,1 TB Hard drive, ISV certified for peak performance, thermal management. Shall be loaded with SCADA software and with latest Windows Operating system, licensed MS Office, licensed Adobe reader, licensed Ani virus,etc
d) CCTV Monitoring station loaded with required software -14$^{th}$ generation Intel core i7 processor and above, 32 GB RAM,1 TB Hard drive, ISV certified for peak performance, thermal management. with latest Windows Operating system, licensed MS Office, licensed Anti virus, etc
e) LIMS system and its integration with SCADA historian system:- 14$^{th}$ generation Intel core i7 processor and above,32 GB RAM,1 TB Hard drive, ISV certified for peak performance, thermal management. Shall be loaded with LIMS software and with latest Windows Operating system, licensed MS Office, licensed Adobe reader, licensed Anti virus, etc
f) LED SCREENS, 65" (1x2) configuration with touch screen functionality (networked with SCADA servers to display the process screens, alarms & reports, CCTV Feeds, with all required hardware & software accessories)
g) Redundant industrial managed Ethernet switches
h) Licensed operating system, Windows server 2025 (or latest at the time of system FAT) for server grade machine, MS Office & Antivirus software to be loaded on each system & servers
i) Industrial grade control system console to house the entire PLC based SCADA system and other equipment as indicated in the system configuration diagram.
j) All required software and hardware to implement the system as indicated in the specifications and system configuration drawings.

k) Each STP Bulk transfer of data (complete plant operational data inclusive of lab data and LIMS data and TSPS Data, complete plant SCADA & lab data mimics) to be transmitted to CP-24 Centralized SCADA center at Shimsha Bhavan, tthrough redundant GPRS communication system.
l) Monitoring of TSPS in real time and receiving of TSPS data from the each TSPS control system and displaying the TSPS complete plant mimics on the STP SCADA screen.
m) Control of TSPS control system from the STP control system as and when required. The feature shall be demonstrated during control system FAT.

The SCADA system shall follow the International Standards Organization (ISO), Open Systems Interconnect (OSI), reference model guidelines. All central system hardware and software devices shall be interconnected using a bus topology data highway. The communications protocol used shall generally meet the requirements of the ISO.
The system shall provide efficient and safe operation of the complete plant by detecting alarm and error conditions, alerting the operator to these conditions both visually and audibly, monitoring all system parameters and providing complete facilities for plant operation and optimization.

The System shall perform all the necessary functions for the optimum monitoring, control and operation of the entire system. For each abnormal condition, Plant failure, Plant unavailable or failure to respond to a command within a given period, the system shall provide the appropriate alarm.

Printed and archived alarms shall be time and date stamped for occurrence and acceptance. Alarms, logs and reports shall be output to separate printers. Alarms shall be in red. The ability to generate alarms within the system software based upon digital and / or analogue events and set points shall be provided.

An alarm horn with silence button shall be provided to alert the operator of an alarm condition. Specific alarm, monitoring and control input / output requirements shall be determined from the particular control specifications and the Project Drawings.

## 13.38 SCADA Software Functions

**General:**

1) The Contractor shall be responsible for supplying complete software packages to enable the equipment to operate as stated in this specification. Provision must be made for the adding of further software tasks as and when required. All software functions shall be user friendly, with instruction and messages to aid the operator. The Contractor shall make available all standard software functions, even if not specifically detailed in the specification.
2) The computers shall utilize a real time multi-tasking and networked operating system with a proven track record in real time control applications.
3) The Application Software shall provide communication with other industrial standard open networks. The Software shall support Object Linked Embedding for Process Control (OPC).OPC should be a in-built feature of the software.
4) The System shall support a fully distributed 64 bit Client/Server architecture. The System shall include Visual Basic for Applications (VBA) as a built-in programming language. Facility shall be available for building custom objects using VBA. Object oriented graphics and tools to easily build reusable control strategies. ODBC Application Program Interface (API) capable of collecting and writing secure real-time electronic records to one or more relational database.
5) The software shall support OPC UA standards as both a client and a server for fast and reliable communications with a wide variety of hardware devices. Provide Active-X controls with selection of third-party Active-X controls for ready-made solutions without VBA programming. The SCADA software shall use SQL server as the integral database.

6) A standard software package, such as Crystal Report shall be provided to facilitate generation of free format, intuitive and presentation quality reports.
7) The engineering& operator workstation's shall be provided with simulation tools to support off-line testing of the control logics.
8) The SCADA Server's shall provide the master clock for the SCADA time synchronization.
9) SCADA software design shall include de-activation of **CTRL+ALT_DEL** windows feature.
10) The system software shall be from the SCADA manufacturer as indicated in the approved vendor list elsewhere in this specification.. Third party software is not acceptable. It is a requirement that the system be supported by on line configuration and editing of all VDU mimic displays and database and to create new displays and additional database.
11) On system boot-up, the SCADA machines(server's, engineering & operator work stations shall directly boot up and go to main operator login screen. Windows access or landing page shall not be accessible. This shall be accessible only to the system administrator.
12) Operational mimics and other graphics shall be presented in an industry standard graphical user interface (GUI) format. A minimum of two active windows shall be displayable concurrently and not more than three windows. Both text and graphics shall resize automatically to accommodate changes made to the size of a window. The system shall be designed to minimize the operator's use of the keyboard. All major functions shall be accessible on-screen through use of the mouse or track ball.
13) Operator system entry, for each area will be password coded with different levels of entry depending on the level of authority of the operator. Development and systems level entry passwords will be provided for engineering workstations. Each action taken by any operator at any level of entry, or at any operator terminal, shall be log file recorded and time and date stamped. Log in and out time and dates will be printed on the control room event logging printer.
14) Right click menu options on SCADA software shall be designed to be disabled as required.
15) All requests and commands shall be via icons, whether menu linked or linked to equipment control actions. A permanent dynamic alarm banner shall be displayed at the bottom or top of each operator screen. Each control action will be routed through a series of confirmation routines.
16) The reports shall be available for printing in graph or tabular format. Dynamic trend displays shall also be available for all analogue flow, level and pressure values. Custom, as well as preconfigured reports and trends shall be available to a higher level of entry. A colour, A4/A3 size, screen dump all in one printer(scan,copy,print) shall be provided for graph and trend prints.
17) An operator help utility shall be provided, offering help linked to the particular action being carried out by the operator at that time. At least one help screen per screen page shall be available. This facility shall be preconfigured with an option for updating by operators, via a password entry.
18) The Application Server software shall be configurable to provide for the monitoring and control of all points, loops, and systems through graphic display screens and hard copy reports. These shall include:

- Parameter Displays for signal control
- Control Loop Status Displays
- Real Time and Historical Data Trend Displays
- Event Displays and Log Reports
- Alarm Displays and Log Reports
- Equipment Diagnostic Displays and Reports.

19) The system shall provide on-line diagnostics that display the current status and operation of the local area network and its nodes. The diagnostic display shall include the LAN adapter status for the machine showing the display, as well as the current number of messages, errors and retries.
20) The system shall conform to and take advantage of industry standards. These shall include, but not be limited to:

- ODBC
- OLE
- ActiveX
- COM/DCOM

- DDE and Advance DDE
- C programming language
- Visual Basic
- Microsoft Windows XP or the most current Operating System
- TCP/IP
- OPC
- XML

21) Display Facilities and screen/mimic refresh: The displays shall be user configurable, with the user being able to construct any desired symbol for display. Any display shall appear (excluding historical recall) within 1 seconds to 2 seconds of selection and the displayed data shall be updated from the database .Alarms shall typically appear within 3 seconds to 5 seconds of occurrence and within 1 second of being received into the central system database. Plant mimics shall display dynamic color details of flow rates and pressures, pump status, well levels, alarms, electrical power supplies and other general equipment status conditions. The plants mimics shall include animation to depict plant process operation, pump running station, media flow within the plant, levels in the tank, etc. The animation shall be designed such that the screen refresh rate shall not effected. The SCADA servers and workstations (engineering & operator) shall be suitably chosen to meet this requirement.

22) The Contractor shall configure all display pages as fully as possible. However, facility must be incorporated to permit easy construction and modification of the display pages, by using a standard library of shapes and symbols. The library shall be added to and modified by the user as required. The configuration shall be object orientated for ease of use.

23) The initial application software shall provide for the display pages listed below and any pages necessary for the system to function as a complete entity.

a) Mimic displays
b) Graphic displays.
c) Trend displays.
d) Alarm summary tables with date and time.
e) Event logs of past 72 hours with date and time.
f) Tabular display of data.
g) Inset windows showing an analogue trends may be mixed with mimic displays. In such a display the main mimic and inset trend shall all be live with automatic display updates.
h) Indexing of information and menus shall be presented in the form of active windows on the screen, while the mimics etc. are still available for view.
i) No display or function shall effect the logging/monitoring of data. It shall be possible for the master station terminal and auxiliary terminals to perform simultaneously, different tasks within the display.

**Monitoring and Alarms**

1) The operator shall be able to monitor all of the information at the workstation. He shall be able to view active equipment information by use of graphical and tabular displays.
2) In the event of an equipment alarm, the following shall occur at the master station:

a) Alarm message displayed in the alarm message area of the screen.
b) The audible alarm shall sound.
c) The appropriate Section of the display page shall change color and flash.
d) A full message shall be written on the alarm page.
e) The full alarm message shall be printed on the alarm printer.
f) The full alarm message shall be recorded, stored on disk and automatically archived.

3) The operator should be able to acknowledge the alarm by pressing an accept alarm key or icon. This action shall stop flashing of all associated alarm messages and displays. However the display shall remain in the alarm state fixed color to indicate an accepted alarm. When all outstanding alarms have been acknowledged the audible alarm shall be silenced.

4) Once the alarm has cleared, the messages and displays shall return to normal. The alarm message shall stay recorded on the event/alarm log and an alarm cleared message shall also be recorded.
5) If the alarm clears before being acknowledged the sequence of events shall continue as above except the message shall change to indicate a cleared alarm.
6) An audible alarm silence function shall be provided to enable an operator to silence the audible alarm without acknowledging all alarms. On occurrence of any subsequent alarm, the audible alarm shall sound.
7) Each signal within the configured system shall be capable of being assigned an alarm based on the following:

a) Four levels per analogue (Lo Lo, Hi Hi, Lo and Hi).
b) Rate of change.
c) Deviation from set point or other control parameter.

8) Alarms shall be time tagged to 1 second resolution at the I/O's.
9) A minimum of four alarm priorities shall be provided so that those requiring immediate attention may be separated from alarms of lower priority. An audible alarm shall sound for alarms requiring operator action.
10) Typical alarm assignments are as follows:

a) critical alarm - an alarm that requires immediate operator action
b) non critical alarm - an alarm that requires operator action but not necessarily immediate action
c) operator guide alarm - an alarm that provides information to the operator
d) event - a low priority condition which is recorded.

**Data Archiving**

Continuous process (analogue) data, digital event states, alarms and operator actions shall be archived to the Historian system.The archive system shall generate an alarm when a file is 60% full.

Analogues will be stored at a rate selected by the operator in the range 1 second to 1 hour. The operator shall have the facility to select the way in which an analogue is stored.

The system will provide any combination of the following:

- Instantaneous value.
- Average value.
- Maximum value.
- Minimum value.
- Not stored.

Maximum, minimum and average values shall be calculated over a period set by the operator in the range 15 minutes to 24 hours, the default shall be 1 hour.

The logging of new data and reception of alarms must be carried out at the same time as the operator is viewing archived data. Any alarms received must be displayed as an overlay on the visual display unit.

The contractor shall submit the Historian data archiving policy to be adopted as part of functional design specifications for review and approval. The same shall be demonstrated during the factory acceptance test and site acceptance test.

**SCADA Screens/Mimics**

The Contractor shall configure all the mimics to provide total detailed coverage of the monitoring and control of equipment as detailed in this specification. It is expected that display modifications will be

required in the future and therefore the ability to change the displays without programming skills is essential.

Instrumentation shall be displayed using ISO standard symbols. For mimic configuration, it shall be possible to call up a library of standard symbols representing items (e.g. pumps, valves) and add new symbols to the library. Building mimics shall be simple and be achieved by using a mouse or tracker ball pointing device.

The mimic displays shall consist of the following pages on a minimum but not limited to:

a) A general diagram covering the entire sewage treatment plant any associated systems on a single screen with key data being displayed. The same shall be constituted as plant overview screen. The same shall be programmed with complete animation to depict the normal process operation and process media flow within the treatment system.
b) A general block diagram for each site or area of Site showing the equipment displayed on a series of single screens with key data
c) Mimic of the equipment and instrumentation connected to each IO module displayed on as many screens as necessary.
d) Individual process screens
e) Entire PLC network monitoring screen
f) Communication interface with control system and other interfaces as required under this contract.
g) Individual vendor packaged PLC monitoring screen
h) Login screens, reports screen, security screen, overall STP screen, etc.. Shall be configured.
i) Screens indicating the current status of each equipment, maintenance schedule/status, Run hours, set points for all equipment inclusive of vendor supplied systems
j) Complete operational screens shall be developed for STP SCADA for vendor packaged system's, irrespective of the vendor system HMI screen supplied.

The SCADA software shall have the ability to limit the number of displays being opened simultaneously at any given point of time. The software shall be able to display at least three different process screens/pop up screens simultaneously and shall be active screens.

**Trend Displays**

It shall be possible to plot dynamically updated real time data and archived data on a line graph, to represent analogue or digital information. Each graph shall be capable of displaying 8 plots overlaid on a graph of different colors and line texture. Next to the graph, there shall be a key relating each color to its function.

The horizontal axis shall be time based and user selectable in minutes, hours, days, weeks, for example, together with a start time.

The vertical axis shall be scaled as a percentage of range and be displayed in the colour of the selected reading. To avoid cluttering, the vertical axis scale shall be changed by selecting the individual display. The vertical axis shall be automatically scaled for each selected point, between limits entered by the user.

Actual values in engineering units shall be displayed by positioning a cursor at the desired point of the trend graph. The display of the data shall also be available in tabular form.

a) Manual Data Entry:

The system shall be provided with facility for entering data manually via the keyboard. This data will fall into two types:

a) Constants which will be changed infrequently. This data may have time and date associated with it.

b) Maintenance related comments.

b) Manually Corrected Data:

The system shall allow a person with authorized access to correct manually, erroneous data via the keyboard.

**Reports**

There shall be a real time spreadsheet facility supplied and installed by the Contractor. The users shall be able to transfer data from either the archive system or live data to the spreadsheet.

The user shall be able to produce daily, weekly, monthly and annual reports using any data and a mixture of formats (tables, graphs, summaries, spreadsheets). It shall be possible to generate reports, either automatically at predetermined intervals, or manually on demand by the Operator.

Typical reports on a minimum would be:

- Inlet and treated flow
- Process parameters
- Laboratory analysis and LIMS data shall be transferred to centralized SCADA system
- Real time data monitoring system report for both inlet & treated flow
- Failures of equipment.
- Analytical instrumentation parameters.
- Wet well and tank levels.
- Discharge pressures.
- Maintenance schedules.
- Power consumption
- Chemical consumption
- Process alarm conditions.
- Status of all vendor control packages

**Profiling**

From an average, typical or manually entered plot, it shall be possible to set an exception profile whereby readings within an upper and lower level are acceptable. Profiles shall be set graphically via OW.

The user may select for the system to alarm if the reading is outside the profile and highlight such exceptions as part of a report, thereby reducing the need to examine all data, to ensure acceptability. The number of exceptions shall be logged.

**Data Manipulation:**

It shall be possible to perform simple mathematical functions on any data, including the following functions:

- Addition
- Subtraction
- Multiplication
- Division
- Square root

It shall be possible to log, display or use in a control loop, the resultant data.

**Database Query Facilities:**

The system shall support the use of database relationships and wild card characters to provide database query facilities. It shall be possible for applications integration to configure queries easily and save them for future use.

Support of Dynamic Data Exchange (DDE) or Structured Query Language (SQL), to permit data exchange between the SCADA and external applications, including spread sheets and databases.

Data shall be presented in tabular format and contain any combination of fields from the main system database. It shall be possible to manipulate the data by specifying search and sort criteria to define data range limits.

Once a query table has been created, it shall be possible to store the configuration and initiate successive look-ups, using a point and shoot technique.

**Downloading IO Configuration:**

It shall be possible to download configuration to the IO's from the engineering work station and the Portable Programming Unit (Laptop).

**Diagnostics:**

The system shall have on-line diagnostic facilities to report system faults as they occur. A set of off-line diagnostic routines shall be supplied for more extensive fault diagnosis.

**Security Access Levels:**

The functions available on the system shall be fully flexible so as to allow users access levels to be customized by the system operator, to suit individual user requirements.

Access to management and engineer levels shall be restricted by user selectable passwords or key switch. The security systems shall be based on a set of privileges, which may be granted or denied to individual uses by the system operator.

Windows functionality of CNTRL+ALT+DEL shall be disabled. On SCADA startup, the system shall load and directly enter in the SCADA welcome home page .The design shall ensure that SCADA software development page shall not be accessed during the startup and only on appropriate login access, the same shall be accessible.

The security/access levels would be divided between Engineers, supervisors and operators.

The system shall be protected from un-authorized changes to the operating system and application programs.

The system shall prevent un-authorized users from re-booting the system or aborting or suspending system-related programs.

The system shall provide three levels of operator access to the system as a minimum, with the first level permitting access to viewing selected plant conditions as described below and the highest level intended for the system manager.

A mechanism shall be provided which prevents users operating at a lower level from accessing functions assigned to a higher level.

The system shall provide a password-protected, user log-on facility for definition of the user access level. Passwords entered during the log-on process shall not be printed or displayed.

The software shall monitor the actions of the user currently logged on at each node and shall log the current user off after a definable extended period of no operator interaction with the system and produce a printed log-off message.

Logging off of the user shall not shut down the system or the SCADA mimic shall not log out. When the operator has logged off, the current SCADA mimic shall be visible for monitoring, but no action shall be possible until the operator has logged in back to the system.

System-generated log messages relating to operator actions, such as alarm acknowledgements or set-point changes, shall include the identification of the current logged-on user.

The Contractor shall provide the following defined user access levels as a minimum and additional levels as instructed by the Employer Representative:

**1) Default Level:**

The default level shall permit users to view all displays except those specifically assigned to a higher level of access.

**2) Operator level:**

The operator level shall permit authorized users to access default level activities in addition to the following:

a) Perform control actions;
b) Acknowledge alarms;
c) Enter or modify manually entered data for inclusion into reports.

**3) System manager level:**

The system manager level shall permit authorised users to access default level and operator level activities in addition to the following:

a) Modify alarm and control set points, dead bands and time delays;
b) Enter or modify historical data;
c) Add, delete or modify individual I/O points or point attributes;
d) Add, delete or modify field device configurations;
e) Create, delete or modify control algorithms;
f) Create, delete or modify graphic displays;
g) Create, delete or modify system reports;
h) Configure trend displays;
i) Access the operating system;
j) Assign access levels and user passwords;
k) Perform any other system maintenance function

**Programming:**

The method of programming will depend upon the Manufacturers system requirements. However, the following standards shall be followed:

a) All programs shall be written such that they lend themselves easily to alterations and additions.

b) Good programming practice shall be followed using structured programming techniques. All programs shall be tidy in format and logical to follow. Programs should be extensively annotated with comments and be self-documenting.
c) The system shall be supplied with programs that use a high level language.

**Programme – Documentation:**
As part of the requirements of this specification full documentation is required as below on a minimum:
a) Software user manuals
b) Database point allocation table
c) Complete program listing, flow charts for all sequences and control routines
d) Application software source code(applicable even for packaged control systems)
e) End user license agreements.

## 13.39 Control Room Furniture:

In addition to the SCADA system equipment, the Contractor shall provide industrial grade system consoles to complement or match both the colour and styling of the equipment. The Control room Furniture shall comply with relevant IEC standards for ergonomic design. System console shall be so designed to house all servers, workstations. Monitors, interface equipment with cables having back entry. Details and design of system consoles shall be submitted to the Engineer for approval. The system console shall be as per the approved vendor list provided elsewhere in this specification.

Typically, The Contractor shall provide five ergonomically designed swivel-type adjustable arm chairs with casters, two lockable cupboard with glass doors , three withdrawable lockable File cabinets to store reports, storage of operating and maintenance manuals, drawings, disks and the like.

## 13.40 Spares for PLC & SCADA

Contractor shall provide all the services and supplies in accordance with approved procedures for handling of spare parts, which shall include arranging for their proper receipt, stacking and storage.

**Spares for Commissioning & Start-up:**
Contractor shall identify, define, procure, and supply construction, pre-commissioning, commissioning and start-up spares, special tools and handling gear for each item of equipment.
On a minimum, 1PLC CPU each (Hot standby PLC, standalone PLC used for TSPS), 3 DI Module, 3 DO Module, 3 AI Module, 3 AO Module, 2 Nos of GPRS communication module, 2 no of managed Ethernet switches of each type installed ,30% fuses of each type and size installed shall be supplied.

The same shall be demonstrated during FAT and before commencement of SAT.

**Spares list for 1st Year of Operation:**
Contractor shall identify, define, procure, and supply construction, pre-commissioning, commissioning and start-up spares, special tools and handling gear for each item of equipment.
These items and quantities should be subject to BWSSB's approval. Upon completion of commissioning, contractor shall take inventory and ensure that spares for first year of operation as identified and defined are available on site.

**Spares List for subsequent 2 Years of Operation:**
Contractor shall identify, define and procure subsequent 2 years of operation, spare parts for each item of equipment.

**Spares List for subsequent years of operation**

Contractor shall identify, define and procure subsequent years of operation, spare parts for each item of equipment as necessary.

Note: Contractor to include Spare list during their bid submission based on the manufacturers recommendation for each item of equipment proposed.

## 13.41 SCADA Hardware Requirements

The system shall support hardware and software interconnectivity to other networks generally in accordance with the ISO Open System Interconnect 7 layer reference model.

**SCADA SERVER –SERVER GRADE MACHINES:**

1) The server hardware shall be of current technology at the time of installation. Server grade machines with Windows server 2025 (or latest) shall be utilized for the SCADA servers on a minimum.
2) Processor-4+ Ghz Quad Core x86-64 on a minimum shall be provided.
3) On a minimum,128GB RAM shall be provided.
4) Hard drive of 4TB SSD shall be provided.
5) The SCADA server machines shall be installed with licensed Microsoft IIS server and .Net runtime license, Windows MS office, Windows server antivirus, etc on a minimum.

ENGINEERING, OPERATOR, LIMS - WORK STATION MACHINE:

1. The computer hardware shall be of current technology at the time of installation. The system shall be supplied with windows 11 version operating system ( or latest at the time of FAT) as released by Microsoft.
2. Processor- 3+ Ghz Quad Core x86-64 on a minimum shall be provided.
3. On a minimum, 32GB RAM shall be provided.
4. Hard drive of 2TB SSD shall be provided.
5. The work stations shall be installed with licensed Microsoft 11 operating system STD edition, windows antivirus(BIT Defender, Checkpoint),MS Office, Adobe reader,etc.

The engineering system must be an open system that, for example, permits the importing of project data from Microsoft Excel, SQL or from CAD/CAE programs. It must be possible to import/export messages to/from Excel and Access for simple processing. Removable memory media must also be provided for each workstation.

It must be possible to back up all database and configuration data both on removable media and on non-removable storage media without the system being offline.
Provision of redundant storage media must be possible for the configuration database. The specs for computer hardware shown are indicative only and minimum requirement to be supplied by the contractor.

6) All workstations, servers, communications equipment and peripherals shall be from reputed manufacturers, suitable for continuous operation and shall be the most currently available models at the time of construction, subject to approval. Adequate spare capacity shall be included to meet the specified requirements and future expansions. All workstations shall not be loaded more than 60% of their capacity. An alarm shall be generated when this capacity is exceeded.

7) The system shall support hardware and software interconnectivity to external Programmable Logic Controllers (PLC's) over an RS-232/RS-485 serial data link using Profibus / Modbus, Ethernet or similar protocol, subject to the approval of the Employer Representative.

**NAS Server (For Historian)**

| Specification | Minimum Requirement |
|---|---|
| CPU | Dual-coreIntel®2.4GHzProcessor |
| Memory | Systemmemory:4GBDDR3RAM |
| | Memory module pre-installed: 4 GBx1 |
| | Total memory slots:4 |
| | Memoryexpandableupto:32 GB (8GBx4) |
| Flash Memory | 512MBDOM |
| Hard Drive | 4 x 2 TB SATA6Gb/s |
| Hard Drive Tray | 8xhot-swappableandlockabletray |
| LAN Port | 2xGigabitRJ-45Ethernetport |
| | (Expandableupto6x1GbLAN or 4 x 10 Gb + 2 x 1GbLAN by installing optional dual-port 10 Gb and 1 Gb network card) |
| LED Indicators | Status,10GbE, LAN, E sata, hard drives |
| Form Factor | 2U, Rackmount |
| Expansion Slot (PCI-E) | 2 |

**DC Power Supplies**

| Specification | Requirement |
|---|---|
| Nominal input voltage | 230VAC |
| Frequency | 47 Hz to 63Hz |
| Input current | 3.2 A typ. At 230VAC |
| Mains failure hold-up time | > 20 ms at 230VAC |
| Nominal output voltage | 24VDC |
| Output current | 10 A at 24VDC |
| Adjustment accuracy | 1% |
| Degree of protection | IP20 |
| Operational indication | LED green (24VDCo.k.),LED red(overload) |

| | |
|---|---|
| Type of mounting | DIN-rail mounting (DINEN50022) |
| Ambient | -10 °C to+70°C |
| Wire Connection | Cage Clamp |
| Type | SMPS, shielded metal case, with provision for earth |

**Intrinsic Safety Barriers**

| **Specification** | **Requirement** |
|---|---|
| Channels | Isolation type IS Barriers, DIN Rail mount |
| Type | DC version, positive polarity |
| Nominal resistance | 300Ω |
| Fuse rating | 50Ma |
| Working voltage | Max. 27 V , 26.5 V at 10 µA |
| Degree of protection | IEC60529 |
| Ambient temperature | -20 ... 60 °C (-4 ... 140°F) |
| Storage | -25 ... 70 °C (-13 ... 158 °F) |
| Degree of protection | IP20 |
| Mounting | Standard35mmDINmountingrail (EN60715:2001) |
| Group, category, type of protection, temperature class | II3GExNaIICT4Gc[deviceinzone2] |
| Directive94/9/EC | EN 60079-0:2009, EN 60079-11:2007, EN 61241-11:2006 , EN 60079-15:2010 |
| IEC Ex approval | IEC Ex BAS09.0142 |

**Surge Protection Barrier**

| **Specification** | **Requirement** |
|---|---|
| Channels | 1-Channel |
| Rated voltage Un | ≤30V |
| Rated current In | ≤250mA |
| Leakage current | ≤5µA |
| On-state voltage | ≤45V |
| Nominal discharge current (8/20)In | 10kA pe rcore,5kA per core(10x) |

| | |
|---|---|
| Max. surge current (8/20)Imax | 20kA per core,10kA per core(1x) |
| Degree of protection | IEC60529 |
| Ambient temperature | -30...80°C(-22...176°F) |
| Degree of protection | IP20 |
| Mounting | DIN rail mount module |
| Group, category, type of protection, temperature class | Ex II 2(1)G Ex ia IICT6 |
| Directive94/9/EC | EN60079-0:2006,EN60079-11:2007 |
| IEC Ex approval | IECEx BAS14.0010X |

**ROUTER for 4G/5G (As applicable)**

| **Specification** | **Requirement** |
|---|---|
| Important 4Gfeatures | • Auto-switch fail over between primary and backup link |
| | • Multichannel-interface-processor (MIP) profile configuration |
| | • Remotely initiated data callback using voice |
| | • Remotely initiated data call back using Short Message Service (SMS) |
| | • Remote firmware upgrade over 4G/5G |
| | • Virtual diagnostic monitoring |
| | • Mobile Equipment Personalization (MEP) lock and unlock capabilities |
| | • SIM lock and unlock capabilities |
| Dual SIM support | • High reliability and cellular multi-homing support for HSPA and HSPA+ based networks |
| | • Dual SIM card socket; compliant with ISO-7816-2 (SIM mechanical) |
| | • Two Internal SIM Card Slots: |
| SMS | • Ability to send and receive SMS (maximum of 160 characters) |
| | • In-band and out-of-band management using Telnet (Cisco IOS Software command-line interface [CLI]) |

| | |
|---|---|
| 4G/5G network management and diagnostics | • Industry-standard 4G diagnostics and monitoring tools (QUALCOMM CDMA Air Interface Tester [CAIT] and Spirent Universal Diagnostic Monitor [UDM]) |
| Included antenna | Two multiband swivel-mount dipole antennae (4G) and one extender (4G-AE010-R) to be included Routers. |
| LED indicators | • Received signal strength indication (RSSI) (green) |
| | • WLAN |
| | • WWAN |
| | • SIM status |
| | • 4G/5G service (green/amber) |
| | • SYS |
| | • ACT |
| IP and IP services features | • Routing Information Protocol Versions 1 and 2 (RIPv1 and RIPv2) |
| | • Generic routing encapsulation (GRE) and multipoint GRE (MGRE) |
| | • Standard 802.1d Spanning Tree Protocol |
| | • Layer 2 Tunneling Protocol (L2TP) |
| | • Layer 2 Tunneling Protocol Version 3 (L2TPv3) |
| | • Network Address Translation |
| | • Dynamic Host Configuration Protocol (DHCP) server, relay, |
| | and client |
| | • Dynamic Domain Name System (DNS) |
| | • DNS Proxy |
| | • DNS Spoofing |
| | • Access control lists (ACLs) |
| | • Ipv4 and Ipv6 Multicast |

| | |
|---|---|
| | • Open Shortest Path First (OSPF) |
| | • Border Gateway Protocol (BGP) |
| | • Performance Routing (PfR) |
| | • Enhanced Interior Gateway Routing Protocol (EIGRP) |
| | • Virtual Route Forwarding (VRF) Lite |
| | • Next Hop Resolution Protocol (NHRP) |
| | • Bidirectional Forwarding Detection (BFD) |
| | • Web Cache Communication Protocol (WCCP) |
| Switch features | • Auto Media Device In/Media Device Cross Over (MDI-MDX) |
| | • 8 802.1Q VLANs |
| | • MAC filtering |
| | • Switched Port Analyzer (SPAN) |
| | • Storm control |
| | • Smart ports |
| | • Secure MAC address |
| | • Internet Group Management Protocol Version 3 (IGMPv3) snooping |
| | • 802.1x |
| Security features | • Secure Sockets Layer (SSL) VPN for secure remote access |
| | • Hardware-accelerated DES, 3DES, AES 128, AES 192, and AES 256 |
| | • Public-key-infrastructure (PKI) support |
| | • 20 Ip sec tunnels |
| | • Dynamic Multipoint VPN (DMVPN) |
| | • Tunnel-less Group Encrypted Transport VPN |
| | • Ip sec stateful failover |
| | • VRF-aware Ip sec |
| | • Ip sec over Ipv6 |

| | |
|---|---|
| | • Adaptive control technology |
| | • Session Initiation Protocol (SIP) application layer gateway |
| | • Zone-Based Policy Firewall |
| | • Stateful inspection transparent firewall |
| | • Secure HTTP (HTTPS), FTP, and Telnet Authentication Proxy |
| | • Dynamic and static port security |
| | • Firewall stateful failover; VRF- aware firewall |
| | Content filtering: |
| | • Cisco IOS Software black and white lists |
| | Integrated threat control: |
| | • Intrusion prevention system (IPS) |
| | • Control Plane Policing |
| | • Flexible Packet Matching |
| | • Hierarchical QoS (HqoS) |
| Ipv6 features | • Ipv6 addressing architecture |
| | • Ipv6 name resolution |
| | • Ipv6 statistics |
| | • Ipv6 translation: Transport packets between Ipv6-only and Ipv4-only endpoints (NAT-PT) |
| | • Internet Control Message Protocol Version 6 (ICMPv6) |
| | • IPv6 DHCP |
| Memory | |
| DRAM | At least 512MB |
| Flash memory | At least 256MB |
| **Interface Support:** | |
| Console or auxiliary port | RJ-45: Single dual-purpose port, which provides direct connection to a console or external modem for management or backup access point |

| | |
|---|---|
| Mini-USB port(RSVD) | Mini-USB port to support remote 4G/5G diagnostics and monitoring tools (QUALCOMM CAIT and Spirent UDM) |
| WAN interfaces | • Wireless WAN with 3G,3.5Gand 3.7Gspeeds |
| | • 10/100/1000 Giga bit Ethernet port |
| LAN interfaces | • Four 10/100 Fast Ethernet ports |
| Standard safety certifications | • UL 60950-1, 2nd edition |

**Broadband Internet**

Broadband internet services with high speed connectivity shall be supplied for connectivity with centralized SCADA center and for web connectivity. The most suitable package of broadband internet service provided by an Internet Service Provider (ISP) which suits the Client's requirement shall be utilized. The contractor shall enter in to SLA agreement to provide continuous fail safe services as required under this contract.

**Fixed Line**

For locations at where ISP is readily available, the technology which supports the broadband services shall be based on Digital Subscriber Line (DSL). The type of DSL utilized shall be of the Asymmetrical Digital Subscriber Line (ADSL) which shall allow simultaneous access to the net and usage of the telephone or fax line Certified ADSL modems shall be utilized. Splitter and micro filter shall be installed on the telephone or fax line to avoid interference.

**Visual Display Unit (VDU)**

1) Visual Display Units (VDU's) shall be color monitor monitor screens, capable of displaying information in alphanumeric, bar histogram, graphical and mimic diagram formats. Monitors shall simultaneously display a minimum of 256 colors, non-interlaced, low radiation, flat screen with no discernible flicker. Display of characters shall be legible and stable on a shadow mask tube, having a resolution of not less, so that 1024 by 768 pixels and a refresh rate of not less than 70 Hz. The units shall include all the necessary picture controls to adjust the sharpness, contrast and position of the image. LED VDUs shall be flat screen, minimum requirements: brightness 250 cd/m2, 500:1 contrast ratio, 1600 x 1200 pixels,
2) VDU's shall be 32 inch LED monitor Screens on a minimum for all SCADA servers, engineering work stations,operaror work stations,LIMS station and Historian station..
3) VDU's shall be fitted with a power management system to reduce consumption upon detection of a stand-by signal from the PC.
4) Note: Each SCADA server, engineering and operator workstation, Historian system, CCTV system shall be provided with VDU units as described above.

**Colour Multifunction Printer:**

Color Multifunction printer shall be used for the production of color screen dumps and reports and shall have a sufficiently sized buffer memory such that system performance will not be degraded when the color printer is operational and comply with the following:

**Printer Specification:**

| | |
|---|---|
| All-in-one functions | Print, copy, scan, fax, standalone scan-to email, photo card slots |
| Multitasking capability | Yes. |
| Paper Size | A3,A4 |
| Print speed, black (normal quality mode) | Up to 21 ppm |
| Print speed, color (normal quality mode) | Up to 21 ppm |
| Print speed footnote | Exact speed varies depending on the system configuration, software program, and document complexity. |
| First page out (color) | As fast as 17.9 sec |
| Monthly duty cycle | Up to 40,000 pages |
| Footnote for duty cycle | Duty cycle is defined as the maximum number of pages per month of imaged output. This value provides a comparison of product robustness in relation to other LaserJet or Color LaserJet devices, and enables appropriate deployment of printers and MFPs to satisfy the demands of connected individuals or groups. |
| | **Paper Heading:** |
| Paper handling standard input | 50 sheet multi-purpose tray 1, 250-sheet input trays 2 and 3, 50-sheet ADF |
| Paper handling standard output | 150-sheet face-down output bin |
| Envelope capacity | Up to 30 envelopes |
| Envelope feeder | No |
| Duplex printing (printing on both sides of paper) | Automatic (standard) |
| Document finishing | Sheet fed |
| Media sizes, standard | Letter, legal, executive, envelopes (No. 10, Monarch) |
| Media sizes, custom | Tray 1: 3 x 5 to 8.5 x 14 in; Tray 2, Tray 3: 3.94 x 5.83 to 8.5 x 14 in |
| Media types | Paper (bond, brochure, coloured, glossy, letterhead, photo, plain, pre-printed, prepunched, recycled, rough), transparencies, labels, envelopes |
| Media weight | Tray 1: 16 to 47 lb (up to 58 lb with Color Laser glossy photo papers); tray 2, tray 3: 16 to 43 lb (up to 47 lb with postcards, up to 58 lb with Color Laser glossy photo papers) |
| Weight | 71.2 lb |
| Processor speed | 450 MHz |

| | |
|---|---|
| Memory, standard | 160 MB |
| Memory, maximum | 416 MB |
| | **Scanner Specification:** |
| Scanner type | Flatbed, ADF |
| Scan resolution, optical | Up to 1200 dpi |
| Bit depth | 42-bit |
| Scan size, maximum (flatbed) | 8.5 x 11.7 in |
| Scan size, maximum (ADF) | 8.5 x 14 in |
| Scan speed (default) | Up to 15 ppm |
| Automatic paper sensor | No |
| | **Copier Specification:** |
| Copy speed (black, best quality, A4) | Up to 20 cpm |
| Copy speed black (best, letter) | Up to 20 cpm |
| Copy speed color (best, letter) | Up to 20 cpm |
| Copy resolution, black | Up to 600 x 600 dpi |
| Copy resolution, color | Up to 600 x 600 dpi |
| Copy reduce/enlarge settings | 25 to 400% |
| Maximum number of copies | Up to 99 copies |
| | **Fax Specification:** |
| Faxing | Yes |
| Fax transmission speed (seconds per page) | 3 sec per page |
| Fax memory | Up to 250 pages |
| Fax note | Based on standard ITU-T test image #1 at standard resolution. More complicated pages or higher resolution will take longer and use more memory. |
| Fax resolution, black (dots per inch) | Up to 203 x 196 dpi |
| Speed dials, maximum number | Up to 120 numbers |
| Auto redial | Yes |
| Fax delayed sending | Yes |
| Fax broadcast | 119 |
| Junk fax barrier | Yes |
| Polling | Yes (receive only) |
| Remote retrieval | No |
| Fax forwarding | Yes |

## 13.42 Cyber Security & Firewall requirements

Centralized Cyber Security Management System shall follow the cyber security policy of BWSSB, it shall felicitate purchaser for Firewall Management, Security Patching, Network Port Management, System Hardening, , Customized Source Code Review and Revision, Patch Management, Anti- Virus Management, Anti-APT Management, Anti- Bot Management, Network Partitioning and Security Zones, , Digital Risk Monitoring and Log Management .It shall be contractor responsibility ensure data privacy owned by BWSSB. Hence contractor and agency shall sign a Non-disclosure Agreement (NDA) with BWSSB.

1. The contractor shall ensure that the System shall conform to ISO:270001 standard in context of cyber security.
2. Cyber security shall be provided at the STP control system and its integration with centralized SCADA center
3. Contractor scope shall include designing of cyber security architecture and operation plans as per principals of cyber security as stated in relevant Govt. of India guidelines. Contractor shall implement system while ensuring periodic updation of anti-malware software, virus definition and firewall security patches.
4. All IT equipment (Server, workstations, firewalls, routers etc.) shall be either Common criteria certified product or relevant test report from STQC (Standardization Testing and quality Certification) shall be submitted. The proposed system shall deal with any type of cyber security breach incident as per cyber crisis management plan (CCMP) and as per advice/guidelines of NCIIPC / Descom-Cert-in.. Implementation Agency (Contractor) shall implement NCIIPC (National Critical Information Infrastructure Protection Center) and CERT-in (Computer Emergency Response Team-India) advisories/guidelines in the system from time-to-time throughout the period spanning from the inception up to the end of operation and maintenance period.
5. Contractor shall conduct bi-annual cyber-security audit of the system without any additional financial implication on BWSSB and Contractor shall allow BWSSB's cyber security auditors/security consultant/BWSSB recommended third party security auditors to conduct audit of the system as and when required.
6. Contractor shall ensure role-based user access of the system and shall submit the details of users from Contractor who will access the system and clearly mention their roles and contractor shall implement two factor authentication of the users in addition to biometric based authentication.
7. Contractor shall submit monthly configuration review report of the system hardware and software to BWSSB. This solution shall provide multiple capabilities to support cyber security best practices. Functionality includes centralized patch management, anti-virus detection updates, centralized account management, logging and event management, whitelisting and automated backup
8. Contractor shall ensure that the hardware and software systems are periodically upgraded throughout operation and maintenance period to minimize system vulnerabilities, availability of latest security patches in the hardware and software while also ensuring compatibility/interoperability among different hardware and software of the systems.
9. Contractor shall submit detailed plan for periodic upgradation of the system and before any system upgradation BWSSB shall be notified well in advance.
10. Contractor shall implement a centralized system for cyber security related monitoring and network management for preventive, detective and corrective actions related to cyber-security.
11. Contractor shall prepare a detailed architecture of the system and data flow diagram of the system compliant with relevant CEA/NCIIPC guidelines
12. Every system and event log shall be retained for at least 06(six) months for review and log shall be periodically reviewed by contractor with log analysis tool. Moreover, logs of the system admin of the contractor shall be kept in a separate data repository which can only be accessed by BWSSB.
13. Contractor shall provide Server codes and documentation for each server.
14. The contractor shall implement in Group policy an active directory server where data has to be exchanged with secured LDAP only

**Next Generation Firewall :**

**Hardware Requirements:**

The device Should be 1RU ; 19 Inch Rack mountable. The appliance should have multicore processor based architecture. The appliance should have minimum 8 x 10/100/1000 Base T Ethernet Port. The appliance should have minimum 2 Ports of 10Gbps SFP+. The appliance should have minimum 2 x USB 3.0 port and one Console Port. The appliance should have minimum internal storage of 1TB SSD for Logs & Reports or better. The appliance Should have Minimum 4GB Memory or better. Proposed solution should not have bandwidth quota limit and time quota limit for manageability of users. The Firewall should be Network DLP compliant for future upgradation.

**License Deliverables:**
User Identity, Next Generation Intrusion Prevention System (IPS),Zero Day Protection / Advance Malware protection, Web Security Essentials / URL Filtering ; Antivirus, URL Filter, Application Filtering, 24x7 Support shall be provided. Hardware warranty shall be provided.

**Performance Capacity:**

The appliance should have minimum Firewall Throughput of 17 Gbps or better. The appliance should have minimum Antivirus Throughput of 2 Gbps or better. The appliance should have minimum Firewall IMIX Throughput of 6 Gbps or better. The appliance should have minimum VPN Throughput of 1 Gbps or better. The appliance should have minimum 4000 Number of Ipsec VPN Peers supported (Site to Site). The appliance should have minimum 3000 Number of Ipsec VPN Peers supported (Client to Site). The appliance should have minimum 3000 Number of SSL VPN Peers supported (Client to Site).The appliance Should support 85+ Web categories.The appliance Should support 5000+ application Signature.The appliance Should support 25000+ IPS Signature
The proposed system should have the future option to integrate with cloud-based management system to manage Firewall. Both solutions should be from the same OEM.The Proposed solution should have a future flexibility / option to provide complete policy enforcement and visibility of roaming users and should restrict the remote user from disabling it.
The Proposed solution should have a future flexibility to apply organization policy framework to the remote users and ideally, it should control the Web and Application filter of the remote user
*The product shall have Indian Standard, IC3S/Common Criteria (provided by STQC in India common-criteria- certification-0 ) or Alternatively from International equivalents, NDPP or NSS or ICSA Lab.*

**Network Management System:**

For effective operations and management of IT Operations , there is a need for an industry-standard Network Management System (NMS). Some of the critical aspects that need to be considered for operations of IT setup of are:
a) Network Fault Management
b) Network Performance Management
c) Server Performance Monitoring

The Monitoring Solution should provide Unified Architectural design offering seamless common functions including but not limited to: Event and Alarm management, Auto-discovery of the Network environment, Correlation and root cause analysis, Reporting and analytics

There should be a tight integration between infrastructure metrics and logs to have the single consolidated console of Infrastructure & security events. Consolidate IT event management activities into a single operations bridge that allows operator quickly identify the cause of the IT incident, reduces duplication of effort and decreases the time it takes to rectify IT issues.

The solution should have capability to perform cross domain correlation with alarm correlation built-in algorithms from Network, Systems and other domain events as well as KPI patterns, also correlation should not be limited to only parent-child or service mapping relationships. The CWMC operator should be able to build correlation rules in a simple GUI based environment where the Operator should be able to correlate cross domain events
The solution shall provide future scalability of the whole system without major architectural changes.The Solution shall be distributed, scalable, and multi-platform and open to third party integration such as Cloud, Virtualization, Database, Web Server, Application Server platforms etc.

The monitoring module of proposed solution must not use any third party database (including RDBMS and open source) to store data in order to provide full flexibility and control on collected data as well as avoiding tempering with SLA calculations.

Proposed NMS solution must be ISO 27001:2013 / ISO 27034 certified to ensure security compliances.All the required modules should be from same OEM and should be tightly integrated for single pane of glass view of enterprise monitoring

**Dashboard:**

The platform must provide complete cross-domain visibility of IT infrastructure issues which should cover all the Network Devices but not limited to Camera, Servers and other SNMP based devices. The platform shall consolidate monitoring events from across layers such as Network, Wi-Fi Controller and APs, Server, Application, Database, UPS etc
The solution should support single console for automated discovery of enterprise network components e.g. network device, servers, virtualization, cloud, application and databases
The solution shall support custom dashboards for different role users such as Management, admin and report users
The solution must allow creating custom data widget to visualize data with user preferences eg. Refresh time, time span, background colour, unit conversion.

The solution shall support custom query based widget with multiple visualization methods including Chart, Guage, Grid, Top N list etc. to visualize and represent collected data with ease. The solution shall provide compehensive query language to pull and plot complex visualization with multiple arithmatic operator such as top, sum, min, max etc.

The solution should provide superior view of infrastructure health across system, networks, application and other IT Infrastructure components into a consolidated, central console.There should be only one dashboard/interface to collected network/server/application/log data after correlation and consolidation across the IT landscape to reduce/correlate number of metrics/alarms

**Network performance Management:**

The solution shall provide discovery & inventory of heterogeneous physical network devices like Layer-2 & Layer-3 switches, Routers and other IP devices and do mapping of LAN & WAN connectivity with granular visibility up to individual ports level.

The solution shall support custom device template to support Generic SNMP devices as well as extensive support on traffic encryption including SNMP v3 with AES-256 encryption
It shall provide Real time network monitoring and Measurement offend-to-end Network performance & availability to define service levels and further improve upon them.

The proposed solution shall provide alert console with alert summary such as no. of correlated alert, network alert, server alert, virtualization alert, cloud alert, application alert etc.
The agents should be extensible and customizable allowing incorporation of any required monitoring source not included in the out-of-the-box monitoring policies. With capabilities to collect and analyze performance data from the operating system and installed applications and use historical patterns to establish performance baselines. All baseline thresholds shall have lower bound, higher bound, polarity, deviation set point and reset point for ease of use. System shall have anomalies detection, outlier detection and stop alarm flooding with these dynamic thresholds.
The solution should classify events based on business impact and also allow defining custom severity levels and priority metrics such as Ok, Critical, Major, Down, Info etc with color codes
The proposed monitoring solution should have capability to configure actions based rules for set of pre-defined alarms/alerts enabling automation of set tasks.
The solution must provide agentless and agent based method for managing the nodes and has the capability of storing events / data locally if communication to the management server is not possible due to some problem. This capability will help to avoid losing critical events.
The NMS admin consol shall provide the ability to start, stop and restart the agent on target server infrastructure and the agent should provide collection capabilities not limited to just KPIs but also support collecting raw logs as well as packets.
The proposed EMS solution must provide agentless as well as agent based monitoring for server infrastructure. The agents should be able to set polling interval as low as 1 second with low overhead on target server infrastructure.
The proposed solution should include a distributed search engine data-store to ingest various types of textual, numerical, geospatial, structured and unstructured data.
It shall provide Real time network monitoring and Measurement offend-to-end Network performance & availability to define service levels and further improve upon them.
The EMS solution shall keep historical rate and protocol data for a minimum of 30 days (most recent) in its short term operating database. All data in that database shall have a maximum 1- minute window granularity. User shall be able to select any 1-minute window over the last 30 days and display unique utilization and protocol data for every monitored interface
The proposed solution should be able to take back up of running and startup configuration of network devices. It should also provide versioning for backup to track changes.

**Network Intrusion Prevention (NPS SYSTEM)**

Network Intrusion Prevention system solution should be dedicated solution designed for OT network & should not be a part of UTM or firewall. The solution shall have dual power inputs which can work simultaneously for power redundancy solution. Also shall support hardware bypass to allow traffic during power failure or system down and solution shall have HA interface for high-availability use and solution shall provide physical diagnostic and test interfaces for hardware troubleshooting. The solution must provide Threat Inspection throughput of at least 10 Gbps(IMIX) and support flexible deployment for different port density requirement and solution shall support out of band management.
The solution shall support industrial control system protocols that are commonly used by industrial systems ( DCS, PLC, SCADA, HMI, OPC, etc.) EthernetIP/CIP (Granular Control Support), OPC, Profinet, Modbus (Granular Control Support), S7COMM (Granular Control Support), S7COMM+ (Granular Control Support), FINS, SLMP (Granular Control Support), SECS/GEM, MELSOFT (Granular Control Support), TOYOPUC (Granular Control Support).

The network based Intrusion prevention solution shall support SAS communication protocols - DNP3, IEC-61850-MMS, IEC-61850-GOOSE, IEC-104.
The solution should support ML-based auto rule learning to build up the operation security baseline and should be able to be configured by its own embedded web console interface and support more than one account for management to login and solution should support VLAN trunk environment.

The solution shall support both of offline mode (IDS) and inline mode (IPS) and solution shall have operation mode support for evaluation stage and support vlan ID detection as one of the packet inspection rule
The solution shall be able to recognize and display information contained in the exchange traffic (ex. Device / protocol / application) and solution shall support the devices support SNMP traps/alerts and solution shall support AD/LDAP/RADIUS/TACACS.
The solution should detect and show protected assets information with real-time traffic along with communication protocols displayed and solution shall record and report detection logs to specified syslog server.
The solution shall support zero configuration via USB & allow user to manually disable the USB port via Web console and solution shall have the capability to connect to 3rd Party solution(such as Nozomi) or SIEM server.
NIPS solution must have capacity for bandwidth management and should have latency of less than 500 micro-second in IPS mode and solution shall be able to provide metadata for IPS event.
The solution shall support order change for rule order in policy enforcement and solution shall be able to select which log types to be sent to syslog server and support Simple Network Management Protocol (SNMP) v1/v2/v3 and should NOT require system reboot for network setting change, should support Link Layer Discovery Protocol (LLDP).
Solution should support up to atleast 15,00,000 TCP concurrent connection and should support configuration backup and upload via USB and should support pattern update to latest version from local storage, authorized management device.

The solution should be compatible and can be deployed within PRP & HSR network architecture and solution should support Malware threat attack behavior detection and prevention: Cryptowall (Ransomware), MIRAI, Hajime, BADRABBIT, HIDDEN COBRA, VPNFilter, Shamoon, ShadowHammer, WannaCry (Ransomware).

The solution shall support password strength mechanism of account management and solution should support to check the packet for OT protocol format compliance and solution should support the firmware downgrade capability and independent configuration for each port pair and port mirror function, support IPS rule pcap capture per triggerd event.

The solution shall support Active Query to discover information for hidden OT assets and solution shall have capability to prevent and detect attack attempts and generate detection log and solution should provide protection to deny of service with specified threshold.

The solution must be able to have whitelisting function to enable packet inspection to allow, block, log incoming traffic based on pre-defined condition (IP address, service type, VLAN ID & protocol type) and solution must have protocol whitelisting function to inspect and allow, block, log insecure and unexpected protocol commands from going through.
The solution shall support the creation of policies to build the baseline for OT traffic control and should support rule editing function to have IPS profile to list out IPS rules and allow user to enable/disable individual rule with desired actions (allow & log, block & log).

The solution shall support to prevent access to specified workstation or system node.
The solution support SMB Granular control and shall be able to analyse SMB exchange and to block or allow frame pass according to data format (SMB v1 / SMB v2/v3) and message type. SMBv1/2/3 granular control filtering options: SMB versions, file access permission: read only, write only, read/write & Drop Ananymous access and solution should support continuous threat detection for OT and IT systems (Alerts, CVE monitoring, work flow, etc.)

The solution should support atleast 40,000 Policy Enforcement rules at network level and should support minimum to 200 IP objects for access control use, minimum 200 profiles for OT protocol filter and advanced matching criteria configuration on IEC-61850-MMS protocol and inspect and block malicious file transfer connection.

The Management console should provide option to have either Physical appliance or virtual appliance, whereas virtual appliance should support installation in VMware ESXi 6.X or above version, VMware Workstation V14 or above version, KVM 2.x or above version and Hyper-V.

Solution shall provide the capability to generate audit records relevant to security for the following events - access control, Error infomration, Backup / restore events, System events, configuration changes and audit log events and solution should support offline license activation for network component.
The solution should support login protection to prevent brute force login into the management system and support self pattern update to cover its application or system vulnerability.
The solution should have vulnerability prevention filters to Protect legacy and critical assets

The solution should have reporting capabilities which must display top N (5 or 10) cyber security events by source IP address, destination IP address, cyber security events, source IP addresses of the protocol filter, destination IP addresses of the protocol filter events, source IP addresses of the policy enforcement events, destination IP addresses of the policy enforcement events and top N (5 or 10) cyber security event types in the selected device group in dashboard.

## Other Aspects of Security

## SCADA Threats Visibility

1) Solution shall be capable to manage from a single console
2) Proposed solution shall be capable of understanding ICS protocols: Modbus, CIP,DNP3, BACNet, IEC-60870-5-104, IEC-60870-5-103, IEC-60870-5-101,Modbus RTU/TCP-IP, IEC

60870-6 (Secured ICCP), IEC 61850, MMS, OPC DA, OPC UA, Ethernet Protocols, and others

3) Proposed solution shall have Deep Packet Inspection capability
4) Proposed appliance shall support ACL (Access control list) based on IEC-104, ACL flow based limiting.
5) Proposed Solution shall have intrusion prevention capabilities for SCADA protocols proposed next generation firewall shall support SCADA Apps/Commands and SCADA protocols.
6) Proposed firewall shall support Firewall rules (incoming/outgoing, management),
7) Proposed solution shall have the ability to log all traffic of above-mentioned protocols and investigate commands down to the parameter level

**Application Security Monitoring**

The standard operating system shall support the monitoring of security on host installed applications. The system shall support or allow the creation of monitoring for:

1) Application Software Error Conditions
2) Application Software Performance Issues
3) Application Configuration Changes
4) Application Logins, etc.

## Security alarms

The system shall be capable of annunciation, to include audible and visual alarms and remote paging whenever a security event takes place and shall support the following:

1) Instant notification through email or SMS
2) Logical grouping of security events by time, location, and device, etc.
3) Interactive dashboard window for viewing and acknowledgement.

**Analysis and reports**

1) The system with the stored information shall be able to produce analyses and reports to meet security compliance requirements. The system shall be equipped with best practices ad-hoc reports widely used in the industry.
2) The contractor personnel shall be trained to be capable of creating new custom analysis and reports, and revising existing, without requiring external consultation.

**Log Archiving and Management Solution**

The security system shall archive, record, and store all security related events in raw form for at least five years. As a minimum, the event logger shall record all security related events from the perimeter security devices and the host IPS. Graphical trend displays of each event shall be available along with specific information on the type of intrusion, the area affected and the source via IP address.

**Signature updating requirements**

The system shall be able to accept timely updates. The updates shall keep the threat signatures current, providing the latest detection and protection. The updates shall also incorporate the latest security enhancements into the Security Management System. These enhancements shall increase security and functionality, without requiring redesign or reengineering efforts.

**Network encryption**

All communication with system constituents shall be encrypted on application level, regardless of the security zone. The mechanisms such as using service session keys .

**Malicious code and Anti-virus protection**

Each of the Windows computers in the system shall be provided with Anti-virus/ software. This monitoring software shall be enabled at all times. The anti-virus application for end points (workstations/servers) shall be different from the gateway antivirus in the Firewalls.

**Security Patch Management**

Security Patch Management services shall be provided through which new security patches and the precautions about installing these patches shall be provided. The cyber security architecture shall permit the distribution of patches without the need for each of the system's computer to be connected to the Internet. The patches shall be updated from the Web server through Internet. These patches shall then be distributed to all other computers and security equipment. The latest patches for all parts of the system shall be deployed before the Factory Acceptance tests.

The patches for Operating system shall be tested on the DTS or Development system before deploying on the real-time system. Similarly, any patches for an application shall be tested on the DTS or development system.

The Contractor shall share all the vulnerabilities with BWSSB as and when they are discovered and shall provide the patches for them.

**Antivirus and Patch Management**

The Contractor shall also be responsible for providing & installing updates/patches for its own software product and Third party software products. All other patches of third-party product like Operating System and Antivirus shall be tested by the Contractor prior to installing .

A secure patch management/deployment system is to be established which will be placed in DMZ. All the patches shall be downloaded through this single point of connection. Other products like IPS, Network IPS, Host based IPS, Firewalls shall also be provided with secure patch management.

The update of firewall signatures shall be preferably deployed on daily basis.

Updates will be provided offline. No external internet access to system will be given.

The Contractor shall provide a mechanism for patch management so that it is known that what patches have been applied, what all patches are pending but available, and what is the recent release of patches for the various products. Any patch shall be applied only with express permission of the BWSSB

## 13.43 Uninterruptible Power Supply (UPS) for Instrumentation, Control & Automation

The UPS shall be floor mounted; self-contained and metal clad and shall be suitable for supplying a non-linear load. It shall be possible to open the enclosure front door when the unit is in use without exposing any live contact to touch.

The complete UPS system shall be installed in a separate room in the administration building, with a separate room for batteries.

The UPS shall be an on-line type incorporating a six pulse rectifier and pulse width modulation inverter technology with microprocessor control. It shall incorporate a static bypass switch which shall operate in the event of UPS failure, overload or manual initiation in order to transfer the output supply to mains without disturbance to the output supply.

The UPS shall incorporate a dc under voltage trip circuit to electronically trip the UPS output in order to protect the batteries.

The noise level of the unit shall not exceed 60dB(A) at 1 m from the UPS cabinet.

The output of the inverter shall be a sine wave having less than 2% THD for linear loads and less than 4% for 50% non-linear load. It shall be suitable for load power factors 0.7 lag to 0.9 lead.

The unit shall have a dynamic response such that a 100% step load causes an output voltage transient of less than ± 4% with a recovery time of less than 4 ms.

For three phase output units the output voltage shall not vary by more than ± 1% for an unbalance of 10%.

The load crest factor shall not be less than 3:1.

The efficiency at full load and 0.8 power factor shall be greater than 88%.

The UPS System shall communicate the following status data to the plant SCADA system to monitor: (Note: To be demonstrated during FAT)

- UPS status
- UPS alarm conditions
- Battery capacity
- Bypass status
- Fault

The UPS shall provide a volt free contact output to indicate:

- warning, i.e. low battery capacity
- fault
- static bypass in use.

The UPS shall have an overload capacity of 150% for 30 seconds and shall be protected in the event of a short circuit of the output.

The batteries shall be housed, either within the UPS enclosure or within a separate matching battery cubicle suitable for location adjacent to the UPS. The UPS battery shall be located in a well ventilated area.

**a) Technical Particulars:**

Each UPS shall have the following features:

a) The UPS shall be stand alone, parallel redundant, true on line, based on advanced IGBT PWM technology with microprocessor based control, monitoring and fault diagnostics, static by pass switch and front access oriented layout.

b) Main Parameters:

| | | |
|---|---|---|
| 1 | Input Voltage | 415V +10% -15 % A.C.<br>Three phase 4 wires with Solidly earthed Neutral. |
| 2 | Symmetrical Short circuit level.<br>Frequency | 25kA<br>50Hz ± 5% |
| 3 | Output Voltage | 240 ± 1% A.C, Three Phase 4 wire with Solidly Earthed Neutral. |
| 4 | Frequency<br>Wave form | 50Hz ± 5%<br>True Sine Wave |
| 5 | Isolation | True on line with complete galvanic Isolation |
| 6 | Total harmonic Distribution | < 2% for linear load,<br>< 3% for non-linear load |
| 7 | Over load Capacity | 125% for 10min<br>150% for 10Sec |
| 8 | Transient Response | Remain within ± 1% and recover to 100% |

| | | |
|---|---|---|
| | | within ¼ Cycle |
| 9 | Crest factor | 3 : 1 |
| 10 | Duty | Continuous |
| 11 | Static by pass | to be provided |
| 12 | Efficiency<br>Converter<br>Inverter<br>Overall | <br>> 94%<br>> 93%<br>> 87% |
| 13 | Max Ambient Temp and Relative Humidity | 45°C & 100% |
| 14 | Cooling | Forced air |
| 15 | Acoustic Noise Level | <60db at 1.5m |
| 16 | Rating & Battery backup | 20 KVA- 120min for full load.(For STP)<br>5 KVA- 60 min on full load (For TSPS) |

c) The UPS shall be complete with Isolation transformer, Converter cum Changer, inverter, protections, indications, programming, microprocessor based monitoring and fault diagnostic system, communication facilities, redundant control power supplies, SMF battery, accessories and interconnecting Cables.

d) Constructional Features: The UPS shall be high quality CRCA sheet steel enclosed suitable for floor mounting. The sheet steel shall be of 2mm thick. All sheet parts shall undergo phosphating process to ensure anti rust conditioning and superior finish. Premier quality powder coating shall be applied. The degree of protection shall be IP 54. The UPS panel shall be provided with two earthing terminals. The final finish shall be Light Grey Semi Glossy Shade 631 of IS 5.

**Converter cum Charger:**

When normal AC supply is available, DC power for the inverter is fully supplied by the converter and the battery is kept under float charge. On main supply failure, the battery shall be automatically connected to the Inverter without interrupting the output voltage for critical load. Similarly on normalization of AC power, the DC load shall be transferred to the converter and battery shall be put on float charge without interruption at output side. The converter cum charger shall be designed to deliver the full load DC required by the inverter and charging of the battery. Battery charging shall be with float & boost mode selection with current limit.

**1) Inverter:**

The static inverter shall convert the power from the converter/battery into stable AC power which is supplied to load. The inverter shall be with the latest IGBT PWM technology with specially designed output transformer.

**2) Battery Bank:**

Batteries shall be 12V, SMF (sealed maintenance free) type. The Qty & AH of batteries shall be suitable for backup period of 120 minutes for full load for STP and backup period of 60 minutes for full load for TSPS .

The battery shall be rated to provide full load power for required backup time on AC power failure. After delivering this amount of power, the battery shall be suitable for recharging through converter cum

charger on AC power restoration. The battery shall be mounted on a separate rack. The battery bank shall be complete with battery stand, interlinks and UPS to battery interconnecting cable.

The battery bank shall be installed in a separate room with good ventilation in the administration building.

**3) Other features:**

The other features of UPS shall be as follows:

i) Microprocessor based Control, monitoring and fault diagnostics.
ii) Comprehensive LED mimic and LED display with keypad Control to enable the following:
a) Date-time stamped event recording and logging in a non-volatile memory
b) Programming and Monitoring of various system parameters
c) Status indications and number of LCD digital meters.
iii) 100% Nonlinear local handling Capability with low distortion of less than 5% and high crest factor of 3:1
iv) RS 232c/ RS 485 interface port.
v) Front access layout.
vi) Inbuilt line chokes for main power supply.
vii) Indications:

- Mains 'ON'
- Converter 'ON'
- Inverter 'ON'
- Battery Low
- Over load
- Inverter Trip
- Charger Trip
- Output 'ON'

viii) Protections:

- Incomer MCCB with Overload & Short circuit releases
- Outgoing MCCB with Overload & Short circuit releases
- Battery MCCB with Overload & Short circuit releases
- Input under/over voltage
- Converter over voltage
- Battery Low
- Battery charging current limit
- Output under voltage
- Output over voltage
- Output over load
- Output short circuit
- Inverter over temp
- Single phase prevention

Alarm and trip conditions shall be separately enunciated.
The backup period shall be minimum 2 hr on full load.

**Testing Requirements**

The Contractor shall carry out specified tests as follows in addition to any tests stated or implied by the foregoing sections of this clause.

The tests shall be carried out on the fully assembled unit utilising the batteries that are to be supplied with the unit.

The Contractor shall demonstrate the following on a minimum as part of SAT of UPS system:

- change-over from full load with mains present to full load on battery supply;
- carry out a discharge test on the system at full load and for the specified duty bridging time period;
- carry out recharge test after operation for the specified duty bridging time at full load. The UPS shall supply the full load during the recharge cycle.
- Demonstrate the full functioning of the complete Field instrumentation,PLC& SCADA system while running on UPS power.
- All Routine/acceptance tests as per relevant Indian / International standards shall be carried out in the presence of Employer / his Employer Representative

**Quality Assurance/Quality Control (QA/QC)**

QA/QVC shall comply with the Contract, with particular requirements specific to the equipment or service being provided as outlined below for PLC & SCADA systems and other equipment that shall comprise the instrumentation and automation system under this contract. The quality assurance/control procedures shall include, but not be limited to the following:

- Continuity and Wiring tests;
- Insulation and High Potential Testing;
- Complete functional test inclusive of calibration;
- Packaging and Shipping;
- Welding;
- Cleaning and Painting.

The quality assurance/quality control documentation shall include, but not be limited to the following:

- Material Certifications;
- Shop Test Reports;
- All other documentation required by applicable codes and standards.

## 13.44 SCADA Control Room design

**Design Considerations**

An ergonomic approach to the design of centralized SCADA monitoring center workstations and the layout of the control room shall contribute to achieving safety and performance objectives set for the centralized SCADA room.

Effective control room design shall consider safety and performance / aesthetic objectives and function to create workspaces that facilitate the complex interaction between operators, technology and the environment. Raised flooring, acoustic concerns, indirect lighting and the wellbeing, health and safety of each operator shall need to be addressed.

Operators in the control room shall work 24 hours a day, 7 days a week.

Control room design shall take into consideration room size, number of operators, viewing requirements and equipment. Operators shall be able to communicate with each other as well as have easy access to essential equipment. The height of the console shall be calculated so the shortest operator can see over the top of any workstation mounted electronics to remote monitor walls, control panels or displays and the clearance underneath the work surface should allow for the tallest operator to sit comfortably.

When designing the control room to address these and other concerns, the following steps shall be taken to ensure operator comfort and minimize fatigue:

- Test console layout with operators for "human tasks" including sequential task simulations.
- Develop workstation layouts designed around acceptable reach zones and visual limitations.
- Take into account maintenance requirements and removal of equipment from both the rear and front of the workstation.
- Provide ergonomic footrests where appropriate.
- Provide 24/7 chairs with full adjustment capabilities.
- Reduce excess heat and noise by locating electronics in an equipment room.
- In workstation dimensions, consider the full height and size range of the operators, utilizing height adjustable work surfaces where appropriate.

The SCADA control room shall be constructed to a high standard to provide a high profile feature and focal point for visitors to the STP.

SCADA control room and associated areas shall be equipped with false flooring & false ceiling. The entire control room and associated areas shall be provided with air-conditioning systems (at least four nos of 2 tonne air conditioners in the main control room & server area).

SCADA control room shall be designed to have maximum view of the plant and plant operation. The brick masonry works in the control room shall be replaced with full length glazed windows with access control system and CCTV system to prevent un-authorised access .No UPS system shall be installed in the control room. A separate UPS room ,separate battery room shall be provided in the administration building for the purpose.

The SCADA control room shall be equipped with false flooring to provide access for all cables. No cables shall be installed over the control room floor.

The SCADA control room shall be provided with air conditioning system .The temperature in any area of the control room shall not exceed 22deg C

**1. Electrical & Earthing Requirements for SCADA control Room**

SCADA Control room Power distribution system shall have redundancy at two levels. The electrical system shall be designed to incorporate spare capacity (Minimum 20%) at each distribution level. All wiring up to the SCADA Control room shall be laid in powder coated MS conduits / Aluminum raceway.

All power cables up to the SCADA Control room shall be PVC insulated type. All cables shall be armored cable type except where flexibility required does not permit use of armored cable.
Earthing system shall be as per IS – 3043.

Contractor shall design and implement anti- static EMI / RFI protection arrangement, wherever necessary.

The contractor shall design, engineer, supply/manufacture, test, erect, install, connect; commission and site test the Electrical Distribution System for any and all power requirements within the SCADA Control room facility. This shall include, but not be limited to UPS, Lighting system, ACDB system and input power to various sub systems of the Server/SCADA Control room like cooling units, alarm systems etc.

Design, engineering, supply, section, wiring, commissioning and testing of all systems are in the contractor scope. Contractor shall design, engineer, supply, commission and test the electrical system considering the various loads it has to cater to.

The technical specifications and the scope for various items provided herein need to be verified by the Contractor. Contractor's scope shall include end to end system that is designed and implemented according to various applicable standards / regulations and meets total requirement for the Server/SCADA Control room Facility.

Copper earth pit station as per IS - 3043 using 600 X 600 X 3 mm copper earth plate complete with accessories and hinged cover shall be provided by the Contractor. Another earthing system shall be extended for equipment body earthing of SCADA control room, using 25 X 3 mmGI strip. Two Earthing pits shall be provided for UPS Earthing, which will be interconnected, and same grid will join the building-earthing grid at only one point. Earthing System shall be designed & maintained considering personnel safety and noise-resistant electronic environments by providing equi-potential bonding with earth resistance of less than 3 ohm. Contractor shall design, supply and implement the most efficient and safe earthing system considering the types of load, fault conditions, cross current circulation, spikes, circulating current due to potential differences, etc.

The earthing system implemented shall ensure safety of people and systems under all conditions. Earth fault protection shall be designed and implemented by the Contractor for all loads

**2. Fire Alarm System**

The contractor scope of work shall include on a minimum, design, engineering, supply and installation & commissioning of Fire Alarm System suitable for control room and all ancillary facilities area.
Fire Alarm System (FAS) shall be designed to detect & suppress the incipient fires and generates audio/ visual alarms in case of fire. The system shall consist of automatic fire detectors and manual call point & break glass units. Automatic fire detector shall work on principle of sensing the smoke, heat or infrared rays.

Detector shall be provided in control room and various location in the administration building. Manual call point shall be provided at exit doors/ routes of control room. Number of detectors and manual call point shall be decided as per guideline and codes.

Fire alarm system shall be microprocessor based fire alarm system and shall have addressable type field devices. It shall comprise following equipment's used in conjunction with addressable automatic detectors & and addressable MCPs.

1. Multi loop Data Gathering Fire Alarm Panel
   (DGFAPs).
2. Sirens & Starters, Hooters, exit signs.
3. Interface with other systems thru Dual redundant data highway with complete network hardware.

System shall be modular and facilitate future extension up to 20%. Redundancy shall be provided at Processor, communication, power supply level. Fire alarm logic shall be programmable type. Minimum number of detectors/ MCPs/ addressable devices in single loop shall be 60 nos. Conductor size of loop cable shall be 1.5 sq. mm copper. All field devices like detectors, MCP shall be addressable type. Fire alarm system shall be interfaced with Fire extinguishing system.

**3. Fire Extinguishing System**

Design, engineering, supply and installation commissioning, puff test, guaranteeing of total flooding (above false flooring + control room + below false flooring) clean agent Fire Extinguishing system for Fire Protection. Clean agent to be considered is HFC227ea, HFC-125, IG-541, IG-100, , IG-55 and IG-01 as per NFPA-2001 for fire protection.

All equipment's shall be approved by UL/FM/Vds/ LPC and TAC accredited agency. Cylinders along with cylinder valve shall be seamless and PESO approved. Clean agent system to be provided shall meet the requirement of NFPA 2001 (Latest).

The system shall include electrically actuated automatic clean agent Fire extinguishing system complete with filled up clean agent cylinders, cylinder rack, manifold, pressure reducing devices, cylinder valves, directional valves, pipes, discharge nozzles, bracket supports, hangers and such other fittings necessary for complete installation of system including necessary civil and mechanical work to complete the above work.

System shall be in operation in following modes
1. Automatically due to fire detection in protected area.
2. Operation of manual release push button located adjacent to protected area.
3. By operating manual lever provided on electrical/ manual control head on pilot cylinder
4. By push button actuation at clean agent control panel.

The system shall include electrically actuated automatic clean agent Fire extinguishing system complete with filled up clean agent cylinders, cylinder rack, manifold, pressure reducing devices, cylinder valves, directional valves, pipes, discharge nozzles, bracket supports, hangers and such other fittings necessary for complete installation of system including necessary civil and mechanical work to complete the above work.

The clean agent shall be discharged / actuated automatically after an adjustable time delay based on the detection signal received. The delay shall be minimum 30 seconds; however it shall be adjustable from 30 to 120 sec. Local control panel of control agent shall be equipped with Hooter. It will operate once gas is released.

**4. False flooring:**

Finished height of Access floor up to 450mm Raised flooring shall be provided.

a. The raised floor must be capable of withstanding a uniform load of 1,220 kg/m2 with a maximum deflection of 2.5 mm.
b. The recommended panel size for the raised floor is 610 mm square. These panels must be easily removable to facilitate access to the under-floor area. Special weather coating on back side of the tiles to be provided.
c. The raised floor must be level within +3.2 mm overall and within +1.6 mm in any 3.05 m (10 ft) distance.
d. Fire resistance of floor material must comply with more stringent, local regulations. It should be totally fire proof.
e. The metallic structure of the raised floor must be electrically bonded to the ground to minimize static buildup. The floor panels must have conductive contact with either the framing, the pedestals, or both for positive electrical grounding.

f. Panel surfaces must be high-pressure laminate. Do not use carpeting. Use material that is both dust and crack resistant. The material must withstand movement of heavy equipment on casters and must resist the buildup of static electricity. Cleaning products containing ammonia must not be used.
g. All cable openings in floor panels must have plastic edging to prevent damage to cables
h. Provide adequate drainage to ensure that no moisture accumulates in the recessed area.

Following provisions for the computer system between the raised floor and the primary floor: shall be provided:

- AC power distribution for the computer system
- Input/output cables.
- Air ducts or passages for cooling air
- Cable ducts

Clearance between the raised floor and the primary floor is 450 mm.

i. The cables are to be routed along the under floor and brought up to the cabinet locations prior to placing the cabinets.
j. Ensure that at least 102 mm (4 in.) of free space exists between the top of the under-floor cables and the raised floor. Route the cables so that excessive buildup does not occur in any local area. Cables routed under the floor that are to connect to electronic equipment must be routed so that excessive strain does not occur on the connector due to inadequate space for bent radius of the cable. In the case of the large diameter input/output cables for peripheral equipment, provide a minimum bend radius of 212 mm (6 in.). All cables are to be routed at 90 degree angles. Power and signal cables must be separated by 150 to 300 mm to minimize noise interference.
k. Matching/approved profiles to be provided.

**5. <u>Industrial system console for SCADA control room:</u>**

The Industrial system console solution shall be capable of performing 24X7 operations under the specified environmental condition. It shall conform to high standard of engineering as mentioned in the document; meeting the specified codes, designs and standards. All the certificates and reports mentioned below shall be submitted as part of datasheet submission.The system console shall be sized to accommodate the complete SCADA system and its ancillaries inclusive of but not limited to the following:

1. Redundant SCADA servers
2. Operator and engineering work stations
3. Historian stations
4. CCTV stations
5. Managed Ethernet switches
6. Other ancillaries

The entire Industrial system consoles shall be warranted for minimum five years against any manufacturing defect.
The Color scheme of the system console shall be as per BWSSB requirements and shall be decided during detailed engineering.

**Minimum Design Criteria for System Console:**

**Structure: -**

Shall be made of heavy duty Extruded Vertical and Horizontal Aluminium profiles of HE9WP grade. The Extrusions shall be duly powder coated with 40+ micron over all surfaces.

To allow future extension and expansion, a weld free system shall be proposed. Interconnecting joints shall not be visible. The structure shall allow easy assembly of Hinged Shutters, Slat wall, Gland Plate, Monitor arms in extremely rigid manner.

**Table top: -**

The material of the working surface shall be minimum 25 mm thick MDF with High Pressure ANSI/NEMA LD3 certified scratch-resistant Laminate.

Front Edge: - shall be with modular Polyurethane (PU) Edge. High density Poly Urethane Foam moulded on industrial grade aluminium core to form 50mm deep tapered edge shall be installed on worktop.
Slat Wall shall be made of minimum 2mm thick Extruded Aluminum (HE9WP aluminum alloy) and designed in such a way that no joints or gaps are visible in the entire width of the console.

Design feature on Monitor Arm Assembly shall have auto-lock, push & add/remove die-cast aluminum extendible arms of 150mm each with tool less addition/deletion feature to cater future requirements.

Shutters & Side Legs: - Front, back shutters shall be of minimum 18 mm Laminated MDF Board with premium finish. Side leg shall be of 25mm of the same finish. Hinges shall have lifetime warranty against manufacturing defects.

**Cable Trays and Wiring**: - The control system console shall be designed with vertical and horizontal cable trays to allow for continuous cable management between the cabinets. Wire shall be routed into the cabinet through gland plate.

**Hardware**: - All bolts shall be of SS material to avoid rust due to environment. Remaining hardware shall be Nickel Plated with RoHS certificate.

## 13.45 Inspection & Testing Requirements for Instrumentation, Control and Automation equipment, other related equipment as required under specifications:

**A. Inspection and Testing Requirements for Instrumentation works**

**1. Inspection, Testing and Setting to Work — General**

Each item of plant shall be subjected to the manufacturer's own tests which shall be certified. Each item of plant and its installation shall be subject to inspection and testing at the place of manufacture. The Contractor shall be responsible for the provision of all necessary test equipment. The Contractor shall demonstrate to the Engineer, the correct operation of any item of plant and the Engineer may witness any test. Tests which, in the opinion of the Engineer, were failed or not performed correctly shall be repeated.

Before any test is made, the Contractor shall submit to the Engineer a full list of test equipment to be used. Each item of test equipment shall have a standard of accuracy better than that stated by the manufacturer of the item to be tested. The Contractor shall provide evidence of the condition and performance of any item of test equipment, in the form of test certificates issued by an appropriate authority independent of the Contractor and manufacturer, or as otherwise directed by the Engineer. Test equipment shall be checked frequently during the period of the tests.

The Contractor's staff responsible for supervising and carrying out tests shall be fully conversant with the various items of equipment of other manufacturers and if necessary the Contractor shall arrange for his

personnel to attend suitable training courses on his own expense. The contractor has to get approval from the client's representative for the training personnel to be employed by the contractor.

Any fault or shortcoming found during any inspection or test shall be rectified to the satisfaction of the Engineer before proceeding with further inspection or testing of that item. Any circuit previously tested, which may have been affected by the rectification work, shall be re-tested.

**2. Preliminary Inspection and Testing at the Place of Manufacture**

**Field Instruments and Analytical Instruments**

After the successful completion of the manufacturer's own inspection and testing of instruments to be supplied under the Contract, complete functional tests inclusive of calibration checks shall be carried out in the presence of the Engineer, engineer's representative and the Contractor at the manufacturer's factory where the instruments have been manufactured. Such tests shall include a demonstration that an increase or decrease of the measured value at several points over the full range of the instrument produces a corresponding increase or decrease in the instrument output signal. These tests shall include checks on the specified accuracy of the instrument at all points. Complete functional testing of all instruments (Field instrumentation inclusive of all Analytical instrumentation, lab equipment & LIMS system, Online Real Time Multi Parameters Continuous Monitoring System for Influent and Treated Sewage Parameters, Auto samplers, wireless communication equipment, etc, covering all instruments and related equipment (Junction box, local control panels, all cables, cable trays)

The entire cost of the complete functional testing, calibration, factory testing any other required testing(interoperability, site visits etc..), including reasonable per diem expenses to cover meals, lodging, transport and similar expenses for all BWSSB (2 Nos) & employers representative personnel (1 No) attending the tests, shall be the responsibility of the Contractor and shall be included in the quoted contract price.

**3. Instrument panels, enclosures and mounting boards**

The manufacturer shall not present instrument panels, enclosures, junction boxes and mounting boards (assemblies) for inspection and testing until the manufacturer's own tests and inspection has been completed. A preliminary inspection and test of these assemblies shall then be witnessed by the Engineer, engineer's representative. The Contractor shall give not less than 15 days' notice in writing that he has completed his tests and inspection and is ready for the witnessed tests and inspection. Where this notice period is different in the Conditions of Contract this shall take precedent.

The witnessed inspection and testing shall include the following on a minimum:

a. Complete functional testing of the instrument inclusive of calibration and sampling system (applicable for all field and analytical instruments, Online Real Time Multi Parameters Continuous Monitoring System for Influent and Treated Sewage Parameters, Auto samplers):
b. A visual inspection of the panel assembly to show that the design, construction and finish are satisfactory and in accordance with the Specification;
c. A check that equipment is securely mounted, accessible for removal or calibration without damage to or undue disturbance of other components, wiring or piping;
d. That all engraving and labels are correctly positioned, fixed and designated in accordance with the Specification;
e. Panel power-distribution circuits have the correct breaker/fuse rating coordination and designation;
f. Power-isolation facilities meet the Specification;

g. The main incoming supply voltage, frequency and/or pneumatic supply pressure is within the required limits, these being checked at the beginning and end of the test and the results recorded on test certificates;
h. The output of all power supply units again at the beginning and end of the testing with results being recorded;
i. The power supply voltage or air pressure of all component instruments of the assembly(s), these voltages/pressures being recorded on the test certificate;
j. The insulation resistance of all circuits except sensitive electronic equipment which is liable to damage by application of the test voltage, such circuits being disconnected before making the insulation resistance tests and these tests being carried out in accordance with IEE Wiring Regulations;
k. That the clean earth bar is isolated from main frame of the panel. Internal lighting and anti-condensation heaters and associated thermostats, isolators, limit switches and wiring shall be checked for compliance with the Specification. Spare capacity within the panel(s) shall be checked to see that it complies with the Specification. This shall include future equipment space, spare terminals, space in wiring trunking and provision for additional cable entry.

**4. Functional Testing at the OEM factory where the equipment has been manufactured**

**General requirements**

Once the preliminary inspection and testing is complete to the satisfaction of the Engineer, functional testing shall commence in the presence of the employer and employer's representative for 100% quantity of all equipment. The purpose of the functional tests are to demonstrate that all instruments and analytical instruments, Online Real Time Multi Parameters Continuous Monitoring System for Influent and Treated Sewage Parameters, Auto samplers, wireless communication equipment, etc, covering all instruments and related equipment (Junction box, local control panels, all cables, cable trays), panels' enclosures and mounting boards (assemblies),sampling system conform to requirements of the Specification. Functional testing on a minimum shall include, calibration check as per established international standards, transmitter function check, error reporting, alarm functions, communication check with external third party devices, etc.

Not less than 30 days before the commencement of functional tests, the Contractor shall submit to the Engineer, for approval, two copies of comprehensive test procedural documents detailing each test to be carried out. The document shall include results forms on which the results of each test will be entered. The forms shall include spaces for numerical values, where necessary, and witness signatures. All applicable drawings and data shall be provided at the place of inspection by the Contractor.

The Contractor shall provide all test instruments and equipment necessary to test the assemblies in their entirety.

The following is a typical list of the equipment required:

• Switch boxes;
• Indicator light boxes;
• Analogue signal sources;
• Dummy loads;
• Meters;
• Simulators;
• Desk-top computers;
• Programmers for PLC or outstations;
• Insulation test equipment.

The entire cost of the complete functional testing, calibration, factory testing any other required testing(interoperability, site visits etc..), including reasonable per diem expenses to cover meals, lodging, transport and similar expenses for all BWSSB (2 Nos) & employers representative personnel (1 No)

attending the tests, shall be the responsibility of the Contractor and shall be included in the quoted contract price.

**5. Quality Assurance/Quality Control (QA/QC/QAP)**

QA/QC shall comply with the Contract, with particular requirements specific to the equipment or service being provided as outlined below for ICA system and in full compliance to clause 16.35, sub clause-1,2,3 & 4, as detailed in above specifications. The quality assurance/control procedures shall include, but not be limited to the following:

- Continuity and Wiring tests;
- Calibration check:
- complete functional testing of equipment along with sampling system(as applicable):
- Insulation and High Potential Testing;
- Packaging and Shipping;
- Welding;
- Cleaning and Painting.

The quality assurance/quality control documentation shall include, but not be limited to the following:

- Material Certifications;
- Shop Test Reports;

All other documentation required by applicable codes and standards.

**B. Inspection and Testing Requirements for Control &Automation works**

**a) Factory Acceptance Test (FAT)**

The Contractor shall conduct a full programme of tests of the PLC & SCADA system at the Contractor's system integrator testing facility in the presence of the Engineer to verify that all features of the system have been provided, are operating correctly and are in full compliance with the Specification. Unless otherwise specified, the entire PLC & SCADA system shall be assembled and tested together as an integrated system, including all master station equipment, all operators' consoles, all outstations and telemetry equipment all instrumentation panels and uninterruptible power supplies included in this Specification. The scheduled date for the factory acceptance test shall be as agreed by the Contractor and the Engineer at least four weeks before the test.

**Note:** ***The PLC and SCADA system shall be conducted as one complete system FAT only. No separate FAT for PLC and separate FAT for SCADA system shall be conducted.***

Not less than one month before the scheduled factory acceptance test, the Contractor shall submit to the Engineer for approval two copies of a comprehensive manual detailing each test to be conducted. The manual shall include a results form on which the results of each test will be entered, including spaces for numerical values where appropriate and witness signatures.

Not less than 21 days before the scheduled factory acceptance test, the Contractor shall submit the internal completed FAT test reports to the Engineer as per contract requirements, which has been witnessed and signed by the contractor representative and that, in the opinion of the Contractor, the system exhibits stable operation and is ready for the formal factory acceptance test by the employer and the employer's representative.

The factory acceptance test will be considered successfully completed only when the system has successfully passed all factory tests as detailed in the FAT procedure and Functional design specifications. The system shall not be delivered to Site until the successful completion of the factory acceptance test is certified by the Engineer. Delay in the delivery of the system due to failure of the factory acceptance test shall not constitute an unavoidable delay. If the system fails the factory acceptance test, the test shall be extended or rescheduled at the discretion of the Engineer.

All hardware to be used in the testing of the system shall have passed an agreed preliminary hardware performance test to ensure known hardware operability before software testing begins.

After successful completion of the factory acceptance test, no software changes shall be made to the system without written authorisation by the Engineer. Any changes to the system which effect the system software documentation, such as input scale modifications or changes to the control logic, shall be entered into the system documentation before delivery of the system to Site.

The entire cost of the complete functional testing, calibration, factory acceptance testing (FAT), any other required testing(interoperability, site visits etc..), including reasonable per diem expenses to cover meals, lodging, transport and similar expenses for all BWSSB (2 Nos) & employers representative personnel (1 No) attending the tests, shall be the responsibility of the Contractor and shall be included in the quoted contract price.

**b) Factory Acceptance Test Procedures**

**1) General**

The scope of the tests shall include the proving of every aspect of hardware and software operation and functions as detailed below.

**2) Hardware tests**

(a) Verify the correct inventory of hardware including cables and printed circuit boards;
(b) Demonstrate that all spare-memory, disk-capacity and system-expansion requirements have been met;
(c) Demonstrate all hardware and software diagnostics;
(d) Verify all power supply voltages are within tolerance;
(e) Verify proper earth connections and isolation of instrumentation earth for all equipment;
(f) Demonstrate operation of test simulation and indication equipment and its Suitability for adequate functional testing of all system functions.

**3) Software tests**

(a) Demonstrate the editing of all system parameters including set-points, timers and the like;
(b) Demonstrate system configuration capabilities including the addition and deletion of input and output points, outstations, and all data base parameters;
(c) Demonstrate the addition, deletion and modification of mimic displays and report formats;
(d) Complete control philosophy with all interlocks shall be demonstrated
(e) Historian data check

**4) Functional tests**

The functional tests shall verify proper operation of every specified system function as an integrated system. These tests shall be conducted in conjunction with functional tests of instrumentation and control panels as specified elsewhere. All failures or discrepancies found shall be documented in the test manual.

Following a failure of any functional test, should software or hardware modifications be required it shall be the decision of the Engineer whether the factory acceptance test is to continue, re-start or be aborted. If testing is allowed to continue, any changes which are required shall be described in a system modification document, signed by both Contractor and Engineer and be incorporated into the final factory acceptance test documentation. The failed test shall be re-conducted and the Engineer may require the retest of functions which may be affected by the modification.

The functional tests shall include, as a minimum, the following:

(a) Demonstration that the system meets the requirements of the Specification for response time and speed of screen update

(b) Verification of the accuracy of all analogue input points in the system. The procedure shall include applying the appropriate signal to each analogue input at a minimum of three points within the range of the input, checking for expected numerical results, and verifying appropriate update of related mimic displays. Proper sensing and action by the system to high and low out-of-range inputs shall also be verified

(c) Verification of the proper logic sense, pulse accumulation and rate computation where appropriate, of all digital inputs and verifying appropriate update of related mimic displays;

(e) Verification of all control and sequencing operations and proper operation of all digital and analogue outputs. The procedure shall include simulation of all related process variables for both normal and abnormal conditions, including instrument and component failure, and demonstration of fail-safe response of the system. System outputs shall be indicated with appropriate lamps and indicators;

(f) Simulation of outstation communications errors and failures and demonstration of error detection and handling, failure detection and handling, and appropriate changes to control actions as designed and specified;

(g) Verification of fault detection and diagnostics by inducing a sufficient variety of fault conditions in the system to ensure that detection processes and fail-safe operation are adequately tested;

(h) Demonstration of proper operation of all mimic displays, help pages, reports, operator procedures and historical data accumulation;

(j) Demonstration of proper operation of all outstations following a simulated master station central processor failure;

(k) Demonstration of proper operation of all equipment during both a system wide or isolated power failure, and following power restoration. The procedure shall include the demonstration of battery backup of both master station and outstation for the full length of time specified, and proper operation of power fail, low voltage warning and all associated alarms.

**5) Reliability test**

After successful completion of the functional tests a 48-hour continuous run of the system shall be performed. The test shall be passed if no system function is lost or no hardware or software failure occurs. Hardware failure is defined for this test as the loss of a major component such as the computer, an outstation, a VDU or a peripheral device. Non-repetitive mechanical failures of loggers, push-buttons and the like are excluded.

During this test, the system shall be exercised with simulated inputs and conditions in a manner which approximates the on-site operational environment. Unstructured testing by the Engineer shall be included during this test. Upon any system failure during this period, it shall be the decision of the Engineer whether the reliability test is to continue or be aborted. If testing is allowed to continue any changes to the system which are required shall be described in a system-modification document, signed by both Contractor and Engineer and the document shall be incorporated into the final factory acceptance test documentation.

**c) Factory acceptance test documentation**

As a minimum, the following information shall be included in the factory Acceptance test manual for each test:

- Test identification number;
- Test name and description;
- List of all equipment to be tested including any special test equipment required;
- Description of the test procedure broken down into logical steps, complete control philosophy check;
- Description of the expected system response verifying the completion of each logical step;
- Space for recording the results of the test and the time and date of the test;
- Space for signatures of the Contractor and the Engineer.

In addition, the Contractor shall provide a method for recording and tracing all problems, discrepancies, queries and suggestions regarding the system and software, and for formalised control of any modifications to the system.

**d) Pre-commissioning tests**

The Contractor shall perform pre-commissioning, or preliminary, testing of the SCADA system in accordance with that specified for instrumentation. The purpose of pre-commissioning tests is to confirm readiness of the system for commissioning.

The scope of pre-commissioning tests shall be generally as specified for factory acceptance tests but real field inputs and final control elements shall be used wherever practical to provide inputs to the system and to confirm proper outputs.

Where this is impractical, simulation signals shall be injected as near as possible to their ultimate sources so as to include in the tests as much of the cabling system as possible.

Each process system shall be set to work under manual control and the system tested to confirm proper operation. After proper operation of manual control mode has been verified, tests of automatic controls of each process system shall be conducted wherever practical.

**e) Site Acceptance Tests (SAT)**

The Contractor shall submit all relevant draft operating manuals for the field instrumentation,PLC & SCADA System to the Engineer for approval prior to commissioning tests. Any faults or failures of the system detected during the previous tests shall be noted and corrected to the satisfaction of the Engineer before commissioning is allowed to commence.

As part of commissioning the PLC & SCADA system(complete ICA system inclusive Field instrumentation , Analytical instrumentation, lab equipment & LIMS system, Online Real Time Multi Parameters Continuous Monitoring System for Influent and Treated Sewage Parameters, Auto samplers, LED screen display system, wireless communication equipment, etc, covering all instruments and related equipment (Junction box, local control panels,etc) shall be tested for availability for a continuous period of ninety days. The control and instrumentation system shall be subjected to SAT only after the complete plant electro-mechanical and ICA works have been completed and tested to perform as per contract requirements and both manual and auto mode of operations has been completely tested and found to be as per contract requirements. During this period, the system will perform the normal functions according to the procedures described in the SAT documentation approved by the Engineer.

The system shall have passed the SAT if all major components have been free from fault or failure and exhibit full error-free functionality for 100 % of the total duration of the test. Major components include

all master station equipment, outstations, communications facilities and instrument panel components, excluding push-buttons, switches and lamps and any equipment not supplied by the Contractor. If the system fails to meet the above criteria, the SAT period shall be reinitiated further for a period of thirty days, till such time the complete system exhibit full error-free functionality for 100 % of the total duration of the test.

During SAT, no modifications to the system shall be made by the Contractor without the written approval of the Engineer. Erroneous functioning which requires software modifications or re-configuration to correct, other than set-point or parameter changes, shall constitute a failure of the availability test. Any changes to the system which are required and approved shall be described in a system-modification document, signed by both Contractor and Engineer and the document shall be incorporated into the final test documentation. The test shall be restarted after corrections have been made.

## 13.46 Training Requirements for Instrumentation, control and Automation works

### A. Before Conduction of Site Acceptance Test(SAT)

The system supplier shall conduct training courses for personnel selected by BWSSB. Training shall be conducted by personnel employed by the Contractor/ system supplier familiar with the system supplied and who have experience and training in developing and implementing instructional courses.

Training shall be conducted for a minimum period of two (days) for at least five BWSSB personnel on site ,by the system suppliers (Field instrumentation, Analytical instrumentation, Online Real Time Multi Parameters Continuous Monitoring System for Influent and Treated Sewage Parameters,CCTV systems, Process equipment suppliers (vendor supplied systems), Plant operations, Control & Automation systems, Laboratory systems inclusive of LIMS, etc

The entire cost of the complete training programme, including reasonable per diem expenses to cover meals, lodging, transport and similar expenses for all BWSSB personnel attending the training program, shall be the responsibility of the Contractor/ system supplier and shall be included in the contract price.
The Contractor/ system supplier shall submit information on the training programe for approval, 45 days prior to training program. This submittal shall include a course outline; time required, course schedule, sample workbook and instructor qualification information for each level.

The Contractor/ system supplier shall make a workbook on each course available to every person taking the courses listed herein. The workbook shall be of sufficient detail so that, at a later date, a trainee could review in detail the major topics of the course.

The training times shall be scheduled by the BWSSB in advance with the Contractor/ system supplier so as not to disrupt the BWSSB's/contractor ability to operate the plant.

### B. After Conduction of Site Acceptance Test(SAT)

Training shall be provided for ten (10) of the BWSSB personnel at the STP facility on operations and maintenance of all system components. The training program shall be divided into two segments and shall consist of at least 5 (five) working days, each of 8 (eight) hours duration.This shall include (Field instrumentation, Analytical instrumentation, CCTV systems, Process equipment suppliers (vendor supplied systems), Plant operations, Control & Automation systems, Laboratory systems inclusive of LIMS, etc

The maintenance training program shall be developed for personnel that have electronics maintenance and repair experience and a general knowledge of computer systems, but shall not assume any familiarity with the specific hardware furnished.

As a minimum, the following subjects shall be covered:

- System Architecture and Layout
- Hardware Components
- Module Switch Settings (Configuration Switches)
- I/O Modules
- Power Supplies
- Data Highway:
- Programmer connection
- IOP programming and diagnostic techniques
- Battery replacement and recharging
- PC and workstation familiarization and maintenance:
- Troubleshooting
- Disassembly
- Cleaning
- Component Replacement
- Re-assembly
- The operation training programme shall include the following topics:
- Power-up, bootstrapping and shutdown of all hardware devices
- Interpretation of all standard displays
- Appropriate actions for software and hardware error occurrences
- Use of operator interface displays and keyboards
- Use of printer including replenishment of supplies
- Manual data entries
- Creation and editing of graphic operator display screens.
- Loading of any required software into the system
- Data base creation and editing.

Note: Contractor shall additionally refer to Part-15-Training & advisory requirements for complete training requirements.

**End of Part-13**